Economics and the New Economy: The Invisible Hand Meets Creative Destruction

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As the third millennium begins, the buzzwords "new economy" and "new paradigm" are invoked repeatedly to explain the U.S. economy. In general, these words refer to a view that high-tech innovations and the globalization of world markets have changed our economy enough that we need to think about it and operate within it differently. Perhaps what we notice most is a new Zeitgeist of accelerating change in the worlds of work and knowledge, change that's emphasized in books with titles like *Blur* (Davis and Meyer) and *Faster: The Acceleration of Just About Everything* (Gleick). Unsurprisingly, economists by no means agree that there is a new economy or that there is a need for a new paradigm.

One sign that there has been a fundamental shift is that direct production of goods and services no longer absorbs the preponderance of workers' time. In 1975, production of goods and services ceased being the occupation of the majority of U.S. workers. Never before had a society been so productive that it could afford to assign most of its workers to white-collar tasks such as management, paperwork, sales, and creativity.

As recently as 1900, production workers in

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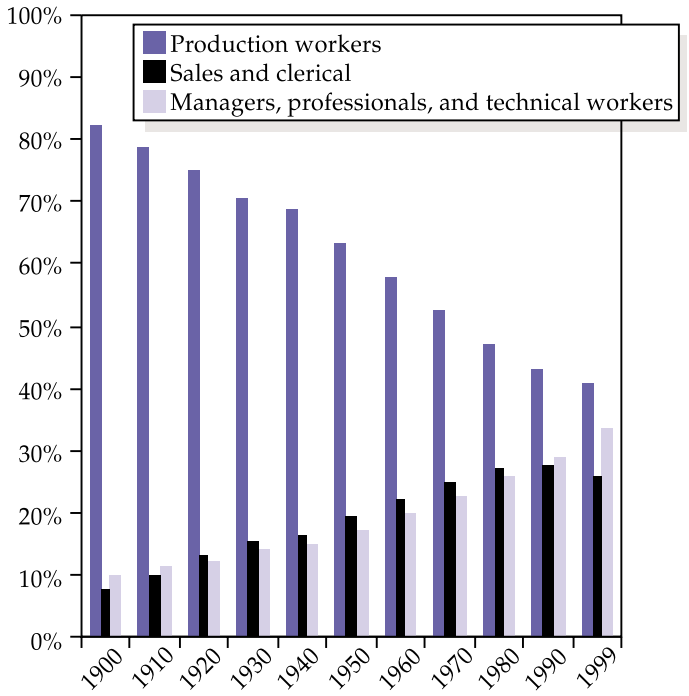
goods and services accounted for 82 percent of the U.S. workforce (Figure).[1] Over the course of the century, that number declined by large steps, to 64 percent in 1950, and to 41 percent in 1999. Managers, professionals, and technical workers, who are increasingly involved in creative activities, have risen from 10 percent of the workforce in 1900 to 17 percent in 1950, to 33 percent in 1999.[2]

In 1999 the U.S. economy employed 7.6 million professional creative workers — 2.3 million engineers and architects, 2.9 million scientists, and 2.4 million writers, designers, artists, and entertainers. At the start of the 20th century, this

FIGURE

The Decline of Production Work

Major occupational categories as proportions of total employment



Source: 1900-70 *Historical Statistics of the United States*. 1980, *Census of Population*. 1990 and 1999, *Employment and Earnings*, January 1991 and January 2000. Production occupations are defined here to include farming, forestry, and fishing; precision production, craft, and repair; operators, fabricators, and laborers; private household and other service workers. Sales and clerical workers include sales workers and administrative support, including clerical workers. Managers, professionals, and technical workers include executive, administrative, and managerial workers, professional specialty workers, and technical and related support workers.

[1]The 1998 occupational data used here are from the Current Population Survey of the U.S. Bureau of Labor Statistics, published in *Employment and Earnings*, and the data for years before 1972 are from the decennial U.S. Censuses of Population as recorded in the *Historical Statistics of the United States*. Production occupations are defined here to include farming, forestry, and fishing; precision production, craft, and repair; operators, fabricators, and laborers; and private household and other service workers.

[2]Managers, professionals, and technical (MPT) occupations include executive, administrative, and managerial workers; professional specialty positions; and technicians and related support. The residual category of occupations is composed of sales and administrative support, including clerical. This sales and clerical category rose from 8 percent of the workforce in 1900 to 19.5 percent in 1950 and grew more rapidly than MPT during that time. It continued to grow more rapidly than MPT until it reached 25 percent in 1970. Since then, however, the proportion of clerical and sales workers has been relatively stable; it amounted to 26 percent in 1999. Much of the function of these workers involves paperwork, the processing of which has been greatly automated in the past 30 years.

group numbered 200,000 workers — less than 1 percent of the 29.3 million workers then employed. By 1950, the count had risen more than five times to 1.1 million—almost 2 percent of the total of 59 million workers. There are now more than six times as many creative professionals as in 1950, representing 5.7 percent of the workforce (Table).

These professional creative workers are paid for their efforts primarily through property rights to their creations: they (and the corporations that employ them) are granted copyrights, patents, brand names, or trademarks. These property rights in turn create temporary exclusivity, temporary monopoly power that negates the unfettered access to markets so prized in economic theory.

The clash between creativity and traditional economics runs deep. Perfect competition is the central paradigm economists have relied on to describe capitalist economies. This paradigm, which underlies Adam Smith's "Invisible Hand" theorem, focuses on production processes and abstracts from the informational tasks that managers, professionals, clerks, and sales workers perform. The paradigm of perfect competition was formulated by William S. Jevons, Leon Walras, and Carl Menger in the late 19th century, a time when direct production of goods and services dominated work.[3] Is this paradigm still appropriate in an age in which innovation is such an important economic activity; millions of workers are employed in *creative* activities, such as designing, inventing, and marketing *new products*; and more and more economic activity is devoted to creating technical progress?

In light of the changes summarized above, perhaps the theory set forth by Joseph Schumpeter and often referred to as creative destruction is a better paradigm for the current U.S. economy. Paul Romer (1998), a Stanford professor of economics and one of the new Schumpeterian theorists, uses the metaphor of cooking to describe direct production as *following existing* recipes while creativity is seen as *creating new* recipes. The new recipes that result from creative endeavors allow a higher standard of living. But creative efforts are risky: while some efforts will fail and yield little, if any, payoff, efforts that yield successful new products are richly

TABLE

Professional Creative Workers

Year	Millions of professional creative workers	Proportion of all employment
1999	7.6	5.7
1990	5.6	4.7
1980	3.7	3.8
1970	2.6	3.3
1960	1.6	2.3
1950	1.1	1.9
1900	0.2	0.7

Sources: 1900-1980, *Censuses of Population*. 1990 and 1999, *Employment and Earnings*, January 1991 and January 2000.

Professional creative workers consist of architects, engineers, mathematical and computer scientists, natural scientists, social scientists and urban planners, writers, artists, entertainers, and athletes.

Minor multiplicative adjustments have been made to exclude teachers of dance, music, and art from the artists and entertainers category in earlier years; teachers of all types are now separated from artists and entertainers in the occupational statistics.

[3]American economist Frank Knight is generally credited with formalizing the paradigm of perfect competition in the first years of the 20th century. His book *Risk, Uncertainty, and Profit* dates from his 1916 doctoral thesis.

rewarded. Firms and workers whose products are outmoded by the new products are harmed. The unevenness of reward implies that an economy that devotes a lot of its resources to creative efforts may have greater inequality, as well as a higher average standard of living, than one that is less creative. And if creativity continues to increase in importance, inequality may continue to rise in the long run, or at least may not decline.

FOLLOWING EXISTING RECIPES: THE WORLD OF THE INVISIBLE HAND

Ever since Adam Smith's *The Wealth of Nations* (1776), most economists have espoused the view that a specific aspect of competition called *perfect competition* is the main spur to economic efficiency. In terms of the metaphor of recipes, this type of competition requires that all firms in an industry have access to the same set of recipes. Let's explore this idea to gain insight into the standard demonstration of the Law of the Invisible Hand.

A recipe for producing a good or a service has a list of ingredients: quantities of inputs, including the services of labor and capital, that go into making the final product. The desire to maximize profits induces each firm to produce the product at the lowest possible cost — that is, to use the recipe that allows the firm to produce the good or service at minimum cost — given the prices of ingredients. If many firms compete, and all of them can use the same recipes, no firm can charge more than the lowest cost at which all competing firms can make the product. If it did, a competitor would offer the product at a lower price and make a profit doing so. If prices of inputs change, firms may adopt a different recipe, but they will still seek to produce at lowest cost, and competition will still force firms to charge no more than the new lowest cost. Thus, a consumer buys from firms that, in their own self-interest, produce products as efficiently as the consumer could wish and charge prices that reflect the lowest possible production cost. Guided by the invisible hand of the marketplace, firms are led by self-interest to behave in a way that maximizes each consumer's well being — so long as there is vigorous competition among firms. This is the Law of the Invisible Hand.

In general, Smith's Law of the Invisible Hand implies that government interference in the perfectly competitive economy is unnecessary except for ensuring that monopoly does not arise. If a firm can exclude other firms from its market, thereby monopolizing a good, it will maximize profits by restricting supply and charging more than the cost of production. When that happens, consumers buy less of the monopolized good than they would at the lower price that competition would force firms to charge. The result is that the economy will operate inefficiently: too little of the monopolized good will be produced and consumers will be worse off than they would be if the good were produced competitively. In this theory, monopoly is a primary threat to the efficiency of a capitalist economy.

In some cases, however, a single producer may yield the lowest cost way of producing a good or service, perhaps because the cost of making an additional unit of the good keeps falling as more units are produced by a producer (economists refer to this as scale economies). In such cases, the government's role is to regulate the monopoly so that it does not artificially restrict supply.

Smith's theory also implies that governments can assist the invisible hand by abolishing artificial barriers to trade. This can force into competition firms that otherwise might have monopolized small markets. At the same time, larger markets encourage individuals to specialize in different parts of the production process and coordinate their labor. In turn, specialization — the division of labor — is the chief engine of increased productivity. Division of labor, according to Smith, owes its power to increase productivity to three sources: "first, to the increase of dexterity in every particular workman; secondly, to the saving of the time which is commonly lost

in passing from one species of work to another, and lastly, to the invention of a great number of machines which facilitate and abridge labor, and enable one man to do the work of many" (p. 7). Smith saw the inventive activity that improved production techniques as being a byproduct of the division of labor, since, when a worker concentrated attention on one activity, time-saving inventions often came to mind. Of course, even in the 18th century, when Smith was writing, the activity of inventors and other creative workers was evident in the economy, but the flow of payments to creative work was minuscule compared with those that flowed to the labor, land, and capital that directly produced products.[4]

Smith saw progress in economic activity as flowing naturally, almost magically, from wider markets. The theory of the invisible hand, as it has evolved within modern economic growth theory, treats both economies of scale and creative activity as *exogenous*, that is, outside the scope of economic theory, and therefore "magical."[5] But an alternative perspective is to describe economies of scale and technical progress as *endogenous* to the economy, viewing creativity as an economic activity. This perspective on economics found its foremost advocate in a Harvard professor named Joseph Schumpeter, who wrote in the first half of the 20th century, during the years when formal corporate research and development first emerged on a substantial scale.

CREATING NEW RECIPES: THE NEW ECONOMY OF CREATIVE DESTRUCTION

Schumpeter argued that what really made capitalism powerful was profits derived from creativity.[6] He believed that the force of habit was extremely powerful in work life and that since economic development required implementing creativity, overcoming this inertia was crucial.

In his masterwork, *Capitalism, Socialism, and Democracy* (1942), Schumpeter constructed a paradigm for economic theory in which creativity was the prime mover in a modern economy, and profits were the fuel. He argued that what is most important about a capitalist market system is precisely that it rewards change by allowing those who create new products and processes to capture some of the benefits of their creations in the form of short-term monopoly profits.[7] Competition, if too vigorous, would deny these rewards to creators and instead pass them on to consumers, in which case firms would have scant reason to create new products. These monopoly profits provide entrepreneurs with the means to (1) fund creative activities in response to perceived opportunities; (2) override the natural conservatism of other parties who must cooperate with the new product's launch as well as the opposition of those whose markets may be harmed by the new products; and (3) widen and deepen their sales networks so that new products are quickly made known to a large number of customers.[8]

[4]Smith ascribes this inventive activity to workers in industries that make capital equipment.

[5]In his book Krugman uses the term magic to describe the exogenous sources of economic growth in a nice exposition of this point of view.

[6]Good academic introductions to this point of view are in the articles by Paul Romer (1986, 1990) and the book by Joseph Stiglitz. Romer (1998) is a good business-oriented popular discussion. The book by Gene Grossman and Elhanan Helpman is an advanced text.

[7]Schumpeter ignores the theoretical possibility that new recipes can be developed and paid for using perfect contracts, where the inventors are paid for their labor and the recipes are then made available freely to all firms. It appears that new consumer products cannot be readily specified in advance, as such a perfect contract would require. The book by Stiglitz discusses evidence that creative destruction is difficult to assimilate into a perfect contract world.

[8]Opposition to new products can arise from consumer and political groups, from workers who make rival products within or outside the firm, or from potential dis-

The drive to temporarily capture monopoly profits promotes, in Schumpeter's memorable phrase, "creative destruction," as old goods and livelihoods are replaced by new ones.[9] Thus, while Adam Smith saw monopoly profits as an indication of economic inefficiency, Joseph Schumpeter saw them as evidence of valuable entrepreneurial activity in a healthy, dynamic economy.

Indeed, Schumpeter's view was that new products and processes are so valuable to consumers that governments of countries should encourage entrepreneurs by granting temporary monopolies over intellectual property and other fruits of creative effort. Thus, in contrast to Adam Smith, Schumpeter argued that government action to prevent or dismantle monopolies might harm growth and the consumer in the long run. [10,11] In practice, temporary intellectual property protection has been adopted by all advanced industrial economies, suggesting that this reward system is indeed valuable in promoting economic growth. To this extent, modern economies have not obeyed the law of the invisible hand. We have made monopoly, albeit temporary, an important instrument of national development policy.[12]

On the other hand, the temporary monopoly protections of intellectual property law are not the only way modern societies reward innovators. For example, much scientific research is generated by grants made by public agencies or private foundations. Development of military products is often done for a fixed payment, which is determined by a bidding process, or on the basis of the incurred and audited costs of the developer. However, these alternative reward systems are employed only where a normal market does not exist for the product. For consumer products, it appears that, in general, the marketplace is the best measure of the value of an invention. The more valuable the product, the greater the reward to its creator should be. And that's exactly what a patent or copyright does — gives the creator a reward that rises with consumer value, because the greater a product's consumer value, the more profit a monopolist can realize from its sales, since the monopolist can charge more for it.[13] At the same time, it remains true that the temporary monopoly itself deprives society of the full value of the creation, since to

tributors. This opposition may be formal or informal, legal or illegal. Consider the recent worldwide opposition to genetically modified agricultural products or the protests at the Seattle meeting of the World Trade Organization.

[9]The monopoly is only temporary; it lasts until a better product comes along that drives out the old or until the patent or copyright expires and others are able to copy the idea or process and compete with the originator. If the grant of monopoly were long-lived, the monopolist would have less incentive to create innovations and might have the power to prevent potential competitors from introducing innovations.

[10]Schumpeter's book gloomily prophesied that capitalism itself would succumb to socialism because of the intellectual disrepute into which economic theory had plunged monopoly and monopolists, when these very monopolists were the heroes of capitalism, properly understood.

[11]Schumpeter may have gone too far; entrenched monopolies can become the enemy of progress. The theoretical model in the article by Stephen Parente and Edward Prescott shows that it is possible for entrenched existing monopolies, such as state-protected employment in the textile industry in India, to prevent the adoption of new, superior technology when entrants have limited ability to profit from the new technology.

[12]Mark Rose's study of the development of English copyright law illustrates the explicit balancing of the property rights of the creator against the desirability of limiting monopoly power.

[13]The theoretical basis for this, as well as modern views of the underlying complexities, is laid out in the article by Suzanne Scotchmer and the one by Francesca Cornelli and Mark Schankerman. One important limitation to the theoretical result is that it assumes away patent races.

secure their monopoly profits, firms limit supply. Thus, the full value of the creation is realized only when the monopoly ends.[14] While Schumpeterian theories tell us some form of intellectual property protection for creators is desirable, they do not yet tell us how much protection to award, for instance, how long patents should last.

There are two important drawbacks to an economy of creative destruction. First, an economy of creative destruction knows only one pace — hectic. There is no way to know who created something except for priority — whoever says or does it first. Once something is discovered, it is easy to copy. Someone who independently creates something, but does so belatedly, does not get credit and does not share in the reward. The rewards of creativity go to the swiftest. It is thus no accident that long hours are a frequent correlate of creative activity.

Second, creative destruction, as its name implies, involves risk and change. Those whose products are outmoded by a new product lose their livelihoods. Even those who create a new product can predict but a small part of its consequences. The forces that oppose creativity are not irrational; they are the natural concerns of economic participants as to how they will be affected by creativity.

WHY ARE THE FORCES OPPOSING CREATIVITY SO STRONG?

Why oppose change and growth in the economy? Because of the riskiness of creating, making, competing against, and buying new products.[15] All activities are at risk in an environment of creative destruction.

Creativity Puts Existing Products At Risk. One aspect of competition within the creative destruction paradigm is what might be called leapfrogging competition, but which economists call a "quality ladder."[16] In this form of competition — which can be observed in video game machines, personal microprocessors, computer software, pharmaceuticals, cell phones, and color televisions — companies try to create new generations of the same product so that the bang for the buck (in economic terms, quality-adjusted value per dollar) rises. A clear example is the personal computer (PC), whose power and speed have been rising at rapid rates for over 20 years.

In the competition to supply components of the PC such as modems or memory, any firm that wants to play the game has to invest in creating new, faster, and smaller versions of the component. To earn profits to justify this investment and its uncertainties, the resulting innovation must leapfrog the competition by creating a new generation. The first firm to market with the new generation can often grab the bulk of the entire market and, with it, almost all the profits to be had. Of course, this typically wipes out the profitability of the previous generation and sets the stage for the next leapfrogger, who will then destroy the profits of the current leader.

Another aspect of creative destruction is competition across different types of products. The creation of a new type of product will, first and foremost, increase the variety of products available to consumers.[17] Beyond that, it will enhance

[14]Robert Hunt's article is a good summary of theoretical and empirical evidence about the uncertainties of optimal patent protection.

[15]Discussions of the impact of increasing risk and inequality in the U.S. are found in the book by Robert Frank and Philip Cook and the book by Michael Mandel.

[16]The pioneering article is the one by Philippe Aghion and Peter Howitt. Grossman and Helpman's book is a nice exposition, albeit at an advanced level. The competition being described is not easy to model mathematically because the firms engaged in this competition have to worry about both the past and the future—the qualities of existing products and the future products that will be discovered—in calculating the likely profitability of their investments.

[17]The seminal paper is the one by Avinash Dixit and Stiglitz.

the desirability of some kinds of products and lower that of others, just as the automobile increased the demand for rubber tires and gasoline and reduced the demand for horseshoes and buggy whips.

More generally, new products encompass both aspects — they can be seen both as quality improvements and as different products that widen the market. Consider new drugs like Celebrex and Vioxx, improved versions of aspirin that minimize the gastrointestinal side effects of long-term use of aspirin and aspirin substitutes. These products have modestly reduced the demand for aspirin, but because of their current high price, their main effect has been to expand the market to those who have had adverse reactions to aspirin and other aspirin substitutes.

Being Creative Is Inherently Risky. You don't know what will work until you try it. While successful new products may earn immense returns, others inevitably fail and cause losses to their creators and their supporters. Every new product is a step into the unknown.[18] Recent examples of products that were expected to fare well in the marketplace, but did not, include the antibiotic Trovan and the 1998 remake of the movie *Godzilla.* Trovan was expected to be a multibillion dollar antibiotic. Its launch in 1998 was a tremendous success: two million prescriptions were written in a year. But of these users, 14 suffered severe liver damage as a side effect, and several died.[19] As a result, Trovan's distribution was limited to use in supervised settings (that is, hospitals) in the United States, and the European Union banned it outright. Now Trovan is no longer expected to be a blockbuster drug. Similarly, among movies, the remake of *Godzilla* was expected to be the summer blockbuster of 1998. Instead, its sales were very disappointing.

Careers and Sequels. For individual scientists and artists, past success is no guarantee of future success. If we could pick winners, we would give those who are going to be productive the resources they need, but often we recognize talent only after the fact. After he published his *Principia*, Newton's scientific output essentially disappeared. Computer laser typesetting pioneer Wang Xuan, of Beijing University, was quoted in *Science* magazine as lamenting, "When I was in my prime, doing the most advanced research, I was not recognized. [N]ow that my creative peak has long passed...my fame grows while I'm making fewer and fewer contributions."[20] This riskiness extends to those who work with creators, because their continued employment may depend on the success of the creators. Some kinds of downsizing can be viewed as the natural consequence of failed creativity, of the inability of a group to maintain a stream of innovation. Of course, in a world of creative destruction, those who don't even attempt to innovate also get downsized. Workers whose employment is attached to outmoded methods of production or outmoded goods suffer large penalties if they are unable to adapt to change.

Networks and Risk. Another aspect of the risk of creative destruction is the fact that consumers also invest in a product or system.[21] If the product or system becomes outmoded, consumers suffer along with the producer. Hence,

[18]The first economist to focus on the fundamental uncertainties of creativity was Frank Knight, and in his honor, this aspect of uncertainty is often called Knightian risk. Because we cannot rely on new creativity to be like past creativity, an empirical analysis of Knightian risk will likely always be at least somewhat unsatisfactory. It also implies that the confidence of investors (which Keynes called their animal spirits) may be an important determinant of the rate of investment.

[19]In clinical trials, 7000 patients were exposed to Trovan and no cases of acute liver failure were reported. ("Questions and Answers about TROVAN Advisory," *FDA Medwatch*, June 9, 1999.)

[20]Quoted in the section "Random Samples," *Science* 285, September 10, 1999, p. 1663.

consumers also must try to pick winners. This effect becomes sharper when the number of consumers investing in a given system influences its value for each consumer, for example, the more of your friends who have email, the more useful email is to you.

Phonograph records suddenly became a risky investment in the 1980s when compact discs took the market. Compact discs offered enough advantages to ensure that new consumers would want to switch to the new technology. Older consumers had to bear switching costs, in particular, their existing collections of records and stereo equipment became outmoded and new records ceased to become widely available.

Betamax looked like a technology winner to most experts when videocassette recorders (VCRs) were invented in the late 1970s. Beta was competing with VHS, and insiders knew that Sony had had the opportunity to develop either Beta or VHS and had chosen Beta as the superior technology. But the corporations that developed VHS were able to more rapidly lengthen videocassette playback times. Consumers who did adopt Beta eventually found that they had to switch to VHS, as Sony was forced to abandon the system by the greater availability of prerecorded videocassettes on VHS.

When consumers do choose a system, the system's rivals may suffer irreversible setbacks, as the Beta system did. This underscores the risks of competition — network competition creates big winners and big losers.

In 1961, back in the early days of the computer, when each piece of computer software was written for a specific model of computer, IBM decided to create an operating system that would permit computer users to use the same programs across the entire family of IBM computers. The difficulty of creating such a system proved much greater than expected, and IBM nearly failed waiting for its completion in 1966 (see the book by Thomas Watson). But once the system was together and operating, IBM's rivals in the computer business were helpless — and virtually all of their important customers migrated to this new system that could grow as they did. Here the "consumers" were large corporate users, whose investments in software became much more durable once they could be used unchanged on different models of computers. IBM's U.S. competitors became known as the Seven Dwarfs. IBM dominated the worldwide computer market for 20 years thereafter.

The costs associated with the riskiness of creativity must be balanced against the gains obtained. Unfortunately, measuring the economic gains due to new products is harder than measuring those from more efficiently produced existing products.

CREATIVITY IS HARD TO VALUE

The investments that consumers make in using a product, or that firms make in new complements, make that product more valuable. When VCRs first came on the market, they were mainly used to record television programs for playback at a more convenient time. But as VCRs proliferated and were able to play longer tapes, they became a convenient format for playing movies. Businesses that rented prerecorded tapes to consumers further enhanced the value of the VCR. Similarly, the development of software and of the Internet have further enhanced the value of personal computers.

Because we learn about the true value of new products only with experience, and because consumers invest in new product systems only over time — and in doing so enhance their value — it takes a long time to know how valuable any given piece of creativity is. The enthusiasm of the moment — whether highbrow or lowbrow — may not be what lasts. Samuel Johnson said

[21]Carl Shapiro and Hal Varian's book gives a readable introduction to consumer network effects that have been the focus of much economic research. John Sutton's book discusses the general issue of consumer investments in a system.

that a century was long enough to judge that Shakespeare's plays were indeed immortal. Shakespeare himself thought that his sonnets would last, but didn't publish his plays.[22] Yet when Harold Bloom argues that Shakespeare created the modern world, he's citing the plays, not the sonnets. Will *Seinfeld* be an important source of humor for the 22nd century? Will John Cage or John Lennon be seen as the more important composer a century from now?

Not only is measuring the value of creativity inherently difficult, but the task is made harder because many of our measures implicitly assume perfect competition. The U.S. Bureau of Economic Analysis (1998) describes the classification of products in the national income and product accounts as follows: "Goods are products that can be stored or inventoried, services are products that cannot be stored and are consumed at the time of their purchase, and structures are products that are usually constructed at the location where they will be used and that typically have long economic lives." This description appears to leave no room for intangible assets, such as the copyright for Windows98 and the patent for Viagra, that result from creative endeavors. These assets are not material and are thus unlike goods and structures, but they may be long-lived, unlike services. Under the theoretical ideal of the perfectly competitive economy, intangible assets do not exist because the monopoly power they imply is ruled out. Put another way, in a perfectly competitive economy, because all recipes are freely available, no one earns a profit from owning one. A direct consequence of the use of the invisible hand paradigm is that the value of creativity disappears from statistical view.

The result is that creativity is poorly measured in the U.S. economy. Our official statistics generally don't treat creativity as an investment (Nakamura, 1999a). This in turn causes the statistics to understate nominal output, savings, and profits. Retail innovations and the proliferation of new products that result from creative activity have made it more difficult to measure the inflation rate (Nakamura 1995, 1998, 1999b). Indeed, our official statistics almost certainly overstate inflation. The combination means that our measures understate real economic growth (Nakamura, 1997).

One of the anomalous features of the U.S. economy is the slow rate of measured productivity growth since the mid-1970s, during this period of intensive creativity. In large part, the reason for this anomaly is that the perfect competition paradigm describes creativity as unimportant, and therefore, our economic statistics tend to ignore it.

However, measures of U.S. economic growth are in the process of being revised. In the 1999 revision to the national income accounts, the U.S. Bureau of Economic Analysis raised the annual growth rate during the period 1978 to 1998 from 2.6 percent to 3.0 percent. As a result of this change, the Bureau of Labor Statistics has raised its estimates of average growth in output per hour in the nonfarm business economy from 1.1 percent to 1.5 percent per year. This change was made primarily because the BEA recognized software as an investment and also improved the measures of financial sector output to reflect product change — in both cases bringing increased awareness of new products' impact on economic growth into the national accounts.

Until the process of revision of our statistical structure is reasonably far along, it will be hard for the economics profession to judge the empirical validity of the paradigm of creative destruction. If there is to be a scientific paradigm shift, then the creative destruction paradigm must explain data better than the invisible hand paradigm does. This in turn requires that the fundamental measures that the economics pro-

[22]In Sonnet 18, Shakespeare promised his now forgotten patron that his verse would be immortal, "So long as men can breathe or eyes can see, So long lives this, and this gives life to thee."

fession uses to generate data be reformulated to reasonably reflect the value of creativity, not only for the current period but for the past. If upon doing so, we observe long-term acceleration of productivity, this observation would provide valuable empirical evidence that the creative destruction paradigm is superior (Romer, 1986). Moreover, if these arguments are correct, we should then be able to describe the sources of economic growth more precisely and convincingly.

Another point of difference between the invisible hand and creative destruction is a prediction about the distribution of outcomes. The Law of the Invisible Hand suggests that competition between workers and companies will tend to equalize wages, whereas creative destruction suggests that markets may tend to magnify inequalities.

IN THE NEW ECONOMY, INEQUALITY MAY BE ON THE RISE

Inequality and Productivity Growth in the U.S. Productivity growth in the U.S. has been phenomenal if we look at long periods of time, even using traditional measures of output. Output per hour has doubled every 30 to 40 years for the past 120 years, leading to a standard of living roughly 10 times higher than that just after the Civil War (see the book by Angus Maddison). Even the poorest U.S. citizens are far better off than in the distant past.

But over the past 20 years, inequality has risen distinctly in the U.S., and creative destruction appears to have had an important role in its increase. While very highly paid male workers earned less than 2.5 times the pay of poorly paid male workers (precisely, the worker at the 90th percentile in earnings compared with one at the 10th percentile) in the 1960s and the early 1970s, the multiple has since risen fairly steadily. Since the mid-1990s, very highly paid male workers have earned roughly four times what poorly paid male workers earn.[23] On average, workers at companies that are engaged in creative activities — as measured by research and development expenditures, investment in computers, and on-the-job training — have earned more and had greater income growth.

The rapid technological change in this period appears to have favored the highly educated — those who are best prepared to create, to assist in creativity, and to learn new ways of working to accommodate the resulting changes.[24] Even though the supply of the highly educated has risen rapidly, demand has outpaced supply, and the value of higher education has risen. Quantitatively, the proportion of the working population over age 25 with at least a bachelor's degree has gone up from 22 percent in 1979 to 31 percent in 1999. The median worker with a college degree earned 68 percent more a week than the median worker with a high school degree in 1999, up from 29 percent in 1979.[25]

There is a clear and close connection between the rising value of college education and the rapid growth of managerial and professional work that is increasingly centered on creativity. A college degree is often required for these occupations, and those who earn college degrees generally enter these occupations. As of March 1997, 62 percent of managers and professionals had bachelor's or advanced degrees. Conversely, 68 percent of all holders of bachelor's or advanced degrees were either managers or professionals. At least some of the value imputed to a college degree is likely to be a return to greater continuing investment in knowledge; holders of college degrees are much more likely than others to en-

[23]See the article by Peter Gottschalk.

[24]For the background to this argument, see the Symposium on Wage Inequality in the Spring 1997 *Journal of Economic Perspectives*, where articles by Gottschalk, George Johnson, Robert Topel, and Nicole Fortin and Thomas Lemieux present a variety of views on skill-biased technical change.

[25]*Economic Report of the President*, February 2000, U.S. Government Printing Office, pp. 135-36.

gage in formal education while working.

And inequality has risen substantially even after we control for measurable changes in education, demographics, and the growth of trade.[26] If the U.S. economy continues to change as dynamically as it has in the recent past — and the evidence on the proportion of the workforce devoted to creativity suggests that it will — there is scant reason for supposing that inequality will decline. Moreover, increases in inequality are occurring not only within the United States but also between the advanced industrial economies and other countries.

Inequality in the World Economy. The paradigm of perfect competition implies that inequality between rich and poor countries should fall as barriers to trade fall. Opening up trade permits countries to specialize more in the products they produce most efficiently. Allowing the unhindered importing of capital lets poor countries adopt the technology of richer ones. Under fairly general conditions, the wages of workers and the return to capital in rich and poor countries will tend to become more similar. Workers in less-developed countries should benefit more than workers in developed countries as both types of economies become more efficient and relative wages of the workers in the less developed countries rise. As global trade increases, average output per person should become less disparate.[27]

But while global trade has increased, the evidence on whether inequality has diminished is, at best, equivocal. Output per worker among the advanced industrial countries has tended to converge, but over long periods of time, the gap between the advanced countries and the less developed countries has not generally diminished. Output per worker throughout the world has risen dramatically, as it has in the United States, but there remain large pockets of poverty in which households produce little more than the bare minimum necessary for subsistence.

According to The World Bank's *World Development Indicators 2000*, the 3.5 billion inhabitants of the low-income countries had an average gross national product per person of $2,170 in 1998.[28] The middle-income countries, with 1.5 billion inhabitants, averaged $5,990 per person that year, while the high-income countries, with 0.9 billion inhabitants, averaged $23,420 per person. As a group, the richest countries generate 11 times as much gross national product per person as the low-income countries.

By comparison, Lant Pritchett has argued that in 1870, the income gap between the high-income countries and the low-income countries must have been less than nine times. While low-income countries have experienced, on average, a very substantial increase in income, so have the high-income countries. The net result is that worldwide inequality has not diminished over the past 130 years. No doubt much of this inequality is the result of bad governance and bad luck, including the rapacity of local oligarchs, disease, war, colonial policy, and civil disorder. This period of history includes extended periods during which trade barriers between nations were quite high and rising, as well.

If we confine our observations to the period since 1960, during which trade barriers around the world have fallen, we also see relatively little decline in income inequality.[29] According to Robert Summers and Alan Heston, gross domes-

[26]See the Symposium in the *Journal of Economic Perspectives* cited earlier.

[27]That international trade tends to increase both equality of returns and efficiency was put on a firm foundation by a series of economists beginning with David Ricardo and continuing to the present. See, for example, the text by Wilfred Ethier.

[28]Product here is measured in terms of its purchasing power in 1998 U.S. dollars.

[29]Trade barriers fell first under the General Agreement on Tariffs and Trade and now under the auspices of the World Trade Organization.

tic product per person in 1960 in the high-income countries was 10 times higher than it was in the low-income countries. Thus, the 1998 ratio of 11 times shows scant convergence even in the recent period of trade liberalization.

Can we expect more rapid convergence in an era in which economic value increasingly depends on creative destruction? Consider the advantages the United States has vis-a-vis a less developed country in the race to create. The U.S. has a well-educated, diverse, and disciplined workforce; access to the most recent research; a deregulated economy relatively unencumbered by bureaucratic restrictions; moderate taxes; a smoothly functioning financial market to finance investment; a long history of rule by law and democracy; a military under firm civilian control; and a host of highly innovative corporations. These absolute advantages count for a great deal in the world of creative destruction, where speed, flexibility, and advanced education all count in developing new products and bringing them rapidly to the marketplace. Indeed, to the extent that creative individuals and firms benefit from geographic proximity, the direct economic benefits of successful creativity will tend to be concentrated in the most advanced countries.

The United States will have these advantages whether or not the less developed countries participate in globalization. Even so, in the long run, less developed countries benefit from the improved ability of the world economy to provide new recipes. But the benefits of globalization should not be oversold. In the short run, rapid obsolescence will tend to deter adoption of new technology in nations where indigenous markets are small. And less developed countries will find it difficult to emulate — and are not allowed by the rules of intellectual property protection to copy — the development of new products. The paradigm of creative destruction implies — in all probability — persistent or even rising inequality between countries.

HOW TO THINK ABOUT A CHANGE IN PARADIGM FOR ECONOMICS

What should the fundamental paradigm of economics be: creative destruction or the invisible hand? This is an empirical matter that depends on the importance of creativity. It is, indeed, hard to measure creativity precisely. But if we fail to recognize it in our economic theory or in our economic measures, we are doomed to be precisely wrong rather than approximately correct. Federal Reserve Chairman Alan Greenspan made this point when he said, "But the essential fact remains that even combinations of very rough approximations can give us a far better judgment of the overall cost of living than would holding to a false precision of accuracy and thereby delimiting the range of goods and services evaluated. We would be far better served following the wise admonition of John Maynard Keynes that 'it is better to be roughly right than precisely wrong.'"[30]

How should economists and noneconomists think about the possibility of a paradigm shift in economics? British Nobel laureate economist John Hicks took up this topic in his 1983 paper on "revolutions" in economics:

> "Our special concern [in economics] is with the fact of the present world; but before we can study the present, it is already past. In order that we should be able to say useful things about what is happening, before it is too late, we must select, even select quite violently. We must concentrate our attention, and hope that we have concentrated it in the right place.
>
> "Our theories, regarded as tools of analysis, are blinkers in this sense. Or it may be politer to say that they are rays of light, which illuminate a part of the target, leaving the rest in the dark. As we use them, we avert our

[30]Testimony of Chairman Alan Greenspan before the Committee on the Budget, U.S. House of Representatives, March 4, 1997.

eyes from things that may be relevant. ...But it is obvious that a theory which is to perform this function satisfactorily must be well chosen; otherwise it will illumine the wrong things. Further, since it is a changing world that we are studying, a theory which illumines the right things now may illumine the wrong things another time. This may happen because of changes in the world (the things neglected may have grown relative to the things considered) or because of changes in our sources of information (the sorts of facts that are readily accessible to us may have changed) or because of changes in ourselves (the things in which we are interested may have changed). There is, there can be, no economic theory which will do for us everything we want all the time."

Put succinctly, Hicks argues that economic science must adapt to the nature of the economy. The growing importance of creative endeavors appears to be what's new in the New Economy. If so, the New Economy represents a significant change in the nature of the U.S. economy, one that is difficult to align with the paradigm of perfect competition. The New Economy is highly competitive, but creative destruction, not production, is the center of the competition. This implies, in line with Hicks's views, that for understanding the New Economy, Joseph Schumpeter's creative destruction paradigm may be superior to Adam Smith's invisible hand.

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