Schumpeter's Creative Destruction:
A Review of the Evidence*

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Thoughtful scholars from Adam Smith to Jared Diamond, have asked the same life-and-death question: why do some societies succeed, and others fail, in producing the goods that make life long, healthy and prosperous? Smith's answer was basically that when societies adopt the rules of market capitalism, their economies grow,:and when they do not adopt the rules of market capitalism, their economies do not. Since Smith, other economists have developed more formal models of economic growth. The classic "Solow growth model" emphasized the investment of capital. Romer's "New Growth Theory," includes knowledge as a variable. What is mainly missing from both the new and the old growth theories is a useful discussion of incentives and entrepreneurship.

The theories are not just academic abstractions. Policymakers, wanting to improve the world, sometimes act in part on the basis of the

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best theories they can find. For example, Jeffrey Sachs, who has been an active advisor to many governments, has recently published (2005) a well-publicized monograph arguing that what is mainly needed to improve living standards in Africa is the investment of large amounts of capital.

But a more thoughtful book, *The Elusive Quest for Growth* by William Easterly, has looked at the track-record of efforts to achieve economic growth through capital investment, and finds that the record is dismal. It is high praise for the character of the founders of the "classic" and "new" growth theories, that both Robert Solow and Paul Romer have words of high praise on the back cover of *The Elusive Quest for Growth*. In the form both of true stories, and more systematic evidence, the book documents the failure of past efforts to help the poor economies grow. It also contains a chapter arguing for the truth and importance of Joseph Schumpeter's account of capitalist economic growth.

Schumpeter's central message is that the process of creative destruction describes the form of competition in capitalism that is capable of dramatic improvements in the quantity and quality of our lives (Diamond, 2004). Many have noted a recent Schumpeter renaissance (e.g., DeLong and Summers, 2001; Friedman, 1999; Rosenberg, 2000; Samuelson, 2003, 467; Useem, 2001). In addition, Schumpeter's message is being illustrated, rigorously documented, extended and elaborated by a group of important business practitioners and academics, notably including monographs by Foster & Kaplan; Christensen; Christensen & Raynor; and Zook & Allen.

In *Capitalism, Socialism, and Democracy*, Schumpeter had a lot to say about his process of "creative destruction," not all of which is given equal emphasis by those using the phrase today. Here, I will distinguish two accounts of the process of creative destruction: Schumpeter's original 'big-is-better' account, and a more recent 'small-is-better' account. The process of creative destruction, in both Schumpeter's original, and in the more recent account, is a process in which

technological advance is the main source of economic growth and improvements in the quality of life. In both accounts, a significant part of the incentive to produce leapfrogging innovations is the prospect of achieving monopoly profits. Traditionally the main source of monopoly profits would have been through patent rights. But currently a full account of monopoly profits would also include network externalities as a source (as with eBay and Microsoft).

Beyond what the two accounts share, Schumpeter's original 'big-is-better' account also claimed that large, monopoly firms are the most able and the most likely to produce new, leapfrogging innovations. This version is the one usually, but not always,[1] associated with Schumpeter's own views. The 'small-is-better' account identifies smaller, often start-up, firms as the most likely source of new leapfrog innovation. I argue elsewhere (2004) that the 'small-is-better' account is what the vast majority of authors have in mind when they apply the phrase "creative destruction" to competition among computer and internet related firms.

Schumpeter's claim was that the new process or product that results from a dynamic leapfrogging innovative competition, is more important in understanding capitalism, than the static standard model of price competition that emphasizes unconcentrated markets as the means to lowering prices, where the goods and the technologies are assumed constant. If one set of rules (standard price competition) maximized one good result (lower prices for consumers); and another set of rules (creative destruction) maximized another good result (new products), then we would have to measure the utility produced by each

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[1]Anne Mayhew has argued (1980) that Schumpeter did not believe that larger firms were necessarily more likely to innovate than smaller firms.

of the good results, which is very hard to do.[2] What if the creative destruction is not only best at producing new products, but also, in creating new processes, is also best at lowering prices for consumers? Then we would know the essential fact about capitalism, without having to decide whether consumers benefit more from lower prices for a constant set of goods, or from a set of goods of higher price, but of increasing variety and quality.

In what follows, I begin by briefly discussing some evidence against the standard price competition model. I then proceed to discuss the benefits of the leapfrogging competition from creative destruction. Finally, I discuss the evidence against the 'big-is-better' account and favor of the 'small is better' account.

Evidence Against the Standard Model of Price Competition

Schumpeter famously claimed that to discuss capitalism without mentioning the process of creative destruction would be like discussing the play Hamlet, without mentioning the Danish prince (1950, 83-85). But, in fact, the most common way to discuss capitalism, in Schumpeter's day and our own, is to omit creative destruction, and focus instead on price competition as the essential element.

The standard model of price competition that is presented in almost all principles of microeconomics texts, tells us that in an unconcentrated market with many small suppliers, the consumer will

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[2]Comparing the benefits from lower prices with those from new products would not be easy. We have highly mathematical models of price competition, and widely understood graphical approximations of these models. Of related, and perhaps equal importance, we have well-understood and frequently-applied methods for measuring the benefits from static competition (notably the consumer surplus concept). In contrast we do not have any widely-accepted mathematical models or graphical approximations explaining the process of creative destruction. And even more importantly, we have found it extremely difficult to measure the benefits of the new product or the new process.

pay lower prices than she would if the same market were more concentrated. The case is strongest when comparing "pure" competition with monopoly. But even there, it rests on assumptions that are not necessarily true, such as that costs would be the same under either market structure. It thus rules out the possibility that monopolies may have lower costs, either through technological improvements, or through economies of scale.

If a large firm, or monopoly, has either sufficiently better technological processes, or economies of scale, then the firm may be earning substantial monopoly profits at the same time that it both lowers prices to the consumer, and introduces important process and product innovations.[3] This is what happened in the famous case of Standard Oil. At the beginning of its ascent in 1870, the price of refined kerosene was 26 cents a gallon, and Standard Oil's cost to produce it was 3 cents a gallon. At the height of its market power in 1885, the price of refined kerosene was 8 cents a gallon, and Standard Oil's cost to produce it was .452 cents a gallon (Armentano, 70). The evidence on Standard Oil suggests that Rockefeller was able to greatly improve the production process,[4] allowing both great profits for himself, and substantially lower prices for consumers.

In more recent times, many analysts (e.g., Simchi-Levi, et al, 2003, 63-64) have painted a similar picture of Wal-Mart. The company has leapfrogged other retailers in the use of information technology to

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[3]It is not clear that we should care how rich some short-term near-monopollists get as long as the consumer benefits with lower prices and better products. But for those who do care, it may be reassuring that William Nordhaus has found that, for the economy as a whole, the size of monopoly profits due to Schumpeterian monopolies is fairly small.

[4]Ron Chernow in his massive biography of Rockefeller provides extensive discussions of how production processes improved under Rockefeller (e.g., pages 79, 100, and especially pages 179-181).

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manage the logistics of the supply chain, and to understand patterns of consumer demand. As a result, the company has both been highly profitable, and provided the consumer with lower prices.

Another case where the firm may have earned substantial profits at the same time that it lowered prices for the consumer may have been what happened with Microsoft. For example, in the early days one reason that Microsoft's DOS became dominant was that it was priced significantly lower than Gary Kildahl's CP/M operating system (Carroll, 1993, 41). For the later period of Microsoft market share dominance, Schmalensee has presented plausible calculations that Microsoft was charging much less than what would be expected from the theory of monopoly-pricing (see Gilbert and Katz, 29).[5]

Evidence that Innovation Competition Matters

Although we are still an early stage of understanding, some progress has recently been made in measuring the benefits to consumers of new product innovation through the process of creative destruction. I will summarize here a couple of papers that illustrate the progress. One particularly illuminating paper is Nordhaus (1997), in which the author compares changes in the true price of light, with changes as measured by traditional price indexes. Traditional price indexes would be based on changes in the price of the good that produces the light (e.g., the bulb) rather than changes in the price of the service being

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[5]Besides the empirical evidence sketched here, both Demsetz and Baumol, et. al., have presented theoretical arguments to suggest that highly concentrated markets may often offer the consumer prices that are as low as those offered in unconcentrated markets. These arguments assume the barriers are not too high to potential competition, and that the incumbents in the market lower their prices to deter entry. Observations of the price competitiveness of many high concentrated, oligopolistic markets (e.g., airlines since deregulation, breakfast cereals, satellite radio), also challenges the usual conclusion that low prices are more likely in an unconcentrated market structure of many small firms.

produced, in this case illumination. One advantage of the case of light is that measures of illumination for various light-producing goods are readily obtainable and do not require the estimation of hedonic price functions, as is required, for instance, in obtaining a price index for the services from computers. For his case, Nordhaus concludes that *"traditional price indexes of lighting vastly overstate the increase in lighting prices over the last two centuries, and the true rise in living standards in this sector has consequently been vastly understated."* (30, italics in original)

In order to understand how representative the lighting sector is of the economy as a whole, Nordhaus classifies (58-60) sectors of the economy into one of three categories: "run-of-the-mill," "seismically active," and "tectonically active." The run-of-the-mill sectors are ones in which either products have changed relatively little since 1800, or else ones for which current price indexes will likely be able to capture most of the changes in quality. The seismically active sectors are those in which the products are still recognizable from 1800, but the quality and characteristics have changed so substantially that current indexes do a poor job of measuring changes. The tectonically active sectors are those in which the changes in product and production process are so large that the current price indexes do not begin to capture the gains.

Of total consumption dollars in 1991 in the U.S., the run-of-the-mill sector was 27.7%, the seismically active sector was 35.8%, and the tectonically active sector was 36.6%. The bias in the current price indexes would thus be expected to be quite large. To illustrate how large, Nordhaus estimates how much the change in real wages from 1800-1992 would be if we make reasonable assumptions about the size of the bias. Using current price indexes, the real wage in 1992 was 13 times the real wage in 1800. By the lowest reasonable estimate of the bias, the real wage in 1992 was 40 times the real wage in 1800. By the highest reasonable estimate of the bias, the real wage in 1992 was 190 times the real wage in 1800.

Another paper that illustrates the progress that is being made in measuring the consumers' gain from leapfrogging technological

innovation, is a paper by Brynjolfsson, Hu, and Smith (2003). Gates (1995) and others had argued that the primary benefit of the internet to consumers was that it would result in lower prices for goods and services. This would occur primarily through quicker, more accurate, and cheaper information about the products and services. In the Brynjolfsson et al paper they measure the gains in consumer surplus for one sector of the internet: online booksellers. They then use techniques recently developed by Hausman and others, to measure the gain to consumers from the greater variety of books made available through internet booksellers. For the single year 2000, they estimate that the increased consumer surplus from increased price competition from internet booksellers falls in a range between $100.5 million and $103.3 million (1591). But for the same period, they estimate that the increased consumer surplus from an increase in variety of books from internet booksellers falls in a range between $731 million and $1.03 billion (1590). These results imply that at a minimum the internet's contribution to leapfrogging innovation is 7.3 times as large as the internet's contribution to lower prices.

Notice that the internet is a general purpose technology, whose applications have resulted in new innovations (e.g., online travel services, online brokers) that have leapfrogged older services. And notice that this leapfrog-enabling technology has both resulted in lower consumer prices, and resulted in new products and services.

We have examined two types of technological advance, and discussed the evidence of the magnitude of the benefits to consumers in each case. The advances in lighting represented a series of leapfrog innovations, the main effect of which was to enormously reduce the price of lighting to consumers (as measured in labor time required per unit of illumination). The advances in book-retailing, enabled by the internet, occurred through a new online retailer (Amazon) developing processes that benefited consumers in terms of price, but also, and even more dramatically, in terms of the variety of the product available.

Individual cases can be suggestive, but the importance of

creative destruction through leapfrogging competition would be strengthened if a broader case could be made. For example, if creative destruction is the essential fact about capitalism, we would expect that the more open the economy is to creative destruction, the faster will be the rate of technological advance, and the greater will be the improvements in longevity, health and quality of life. It is plausible to argue that the United States during the twentieth century was a notable exemplar of openness to creative destruction.[6] If so, then evidence for substantial ·technological advance, and improvements in longevity, health and quality of life, would create a strong presumption for creative destruction indeed being the essential fact about capitalism. In the paragraphs that follow, I will present some such evidence, first in the form of a vivid story from the life of John D. Rockefeller, and then in the form of summarizing some of the findings of economists DeLong, Gordon, and Fogel.

In the year 1900, John D. Rockefeller was the richest person on the face of the earth.[7] Besides what it tells us about medical progress in the 20th century, the following episode in Rockefeller's long life may also help us answer the question of which levels of society benefit most from creative destruction.

Rockefeller's daughter Edith had two sons, Jack and Fowler, whom Rockefeller "doted" on. In late 1900, at roughly the age of four, both boys came down with scarlet fever. Rockefeller was devastated and

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[6]Nicholas has argued (2003, 1025) that the United States was especially open to creative desstruction in the decade on the 1920s.

[7]Klepper and Gunther's *The Wealthy 100* (1996)ranks Rockefeller as the richest American in the History of the United States, based on estimated total wealth at the time of death, as a percentage of GNP at the time of death. See also: "Rockefeller, you know, is reputed the richest man in the world,..." (William James in letter to Henry James, January 29, 1904, quoted in Chernow, ix). Chernow himself describes Rockefeller as the "...world's richest investor..." (Chernow, 373).

offered a New York physician a half a million dollars if he could cure
the boys. If we correct for inflation over the past 105 years, that would
be over $11 million, in 2005 dollars.[8] Edith's relationship with her father
frequently had been strained: she was a free spirit, and he was not. But
at the end of this episode, she wrote a letter to John D. Rockefeller,
saying:

> As long as I live I shall never forget the great love and the
> untiring effort which you put forth to save dear Jack's life . . .
> Absolutely forgetful of self and showing a love much like the
> Christ love. (Edith Rockefeller McCormick as quoted in
> Chernow, 1998, 417-418)

Jack died of scarlet fever on January 2, 1901.

The Merck Manual, a leading physicians' medical desk reference,
says: "Scarlet fever (scarlatina) is uncommon today, presumably because
antibiotic therapy prevents the infection from progressing or causing
epidemics." (Beers and Berkow, 1999, 1152) The "drug of choice" for
scarlet fever is penicillin (1153). Although "discovered" by Fleming in
1928, penicillin only became broadly useful after 1940, when Florey,
Chain and Heatley discovered a practical way to extract penicillin from
mold (see: Lax, 2004).

In 1900, many came down with scarlet fever, and there was a
significant risk of death from the disease, even if you were the grandson
of the richest person on earth. In 2000, in the West, few come down
with scarlet fever, and there is no significant risk of death from the
disease, even if you are living at the official U.S. poverty threshold.

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[8]To make this calculation, I used historical data from p. 210-211, of Part 1 of
Bureau of the Census 1975, for the years from 1900 through 1967. For the years
1967 through February 2005, I used data from the Bureau of Labor Statistics,
rekported online by the St. Louis Federal Reserve at:
http://research.stlouisfed.org/fred2/data/CPIAUCNS.txt.

Although this sort of evidence is not ubiquitous in the mainstream economics literature, it is also not totally without precedent (Adam Smith, 1937, 12; Schumpeter, 1950, 67; DeLong, 2000; Gordon, 2000; Fogel, 2004, 2005). The most ambitious recent version, in both form and substance has been presented (2000, 21-23) in a draft chapter of Bradford DeLong's long-awaited economic history of the United States. DeLong's version begins with the question (21): "What multiple of average income per capita a century ago would be required for that household to feel equally well-off in a material sense, if it were transported back in time?" His first answer (22) is that the multiple would have to be "very large indeed." Personalizing the question, he suggests (23) that even with a very large multiple, "we would *not* be happy."[9] He explains:

> I would want, first, health insurance: the ability to go to the doctor and be treated with late-twentieth-century medicines. Franklin Delano Roosevelt was crippled by polio. Nathan Meyer Rothschild—the richest man in the world in the first half of the nineteenth century—died of an infected abscess. Without antibiotic and adrenaline shots I would now be dead of childhood pneumonia. The second thing I would want would be utility hookups: electricity and gas, central heating, and consumer appliances. The third thing I want to buy is access to information: audio and video broadcasts, recorded music, computing power, and access to databases. None of these were available *at any price* back in 1890 (23; on the Rothschild information, DeLong cites Landes 1998 citing Wilson 1994).

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[9]The sort of argument sketched by DeLong could be objected to on the grounds that it seems to ignore the problem of interpersonal utility comparisons. Sen (1976) and others have noted that one can only rank changing consumption bundles for the same group of consumers.

The rest of DeLong's chapter is full of details about how improvements in technology over the century improved the length and quality of life.

Under a paper heading entitled "How the Great Inventions Helped Us Escape from the Bad Old Days" (57), Robert Gordon devotes several paragraphs to summarizing some of the key findings in Otto Bettmann's *The Good Old Days—They Were Terrible* (1974). The book is richly illustrated from Bettmann's own archive[10] of historical photographs and illustrations from the period 1860-1900. He highlights the stench and disease resulting from the filth of garbage and manure-filled city streets—manure from the horses used for transportation, and from the pigs allowed to roam free to eat the garbage. He highlights the isolation of rural life, the tedium and physical exhaustion from cooking in fireplaces, and cleaning clothes by muscle power. He highlights, the long hours, dangerous, and unhealthy working conditions of many workers.

He also highlights five "great inventions" that he argues vastly improved the ordinary person's length and quality of life: 1) electricity, 2) the internal combustion engine, 3) chemical engineering (leading, e.g., to plastics and medicines), 4) communications inventions (including the telegraph, telephone, and radio), and 5) running water and indoor plumbing. He finally appeals to our subjective judgment of the significance of these great inventions to support his conclusion that the internet is a less important innovation in improving our lives. (This latter part of his argument can be rebutted, if we accept Paul David's (1990) account, based on the history of the electric engine, that with general purpose technologies, the main benefits may not be foreseen in the early years or decades of the innovation—we are still learning the uses of computers and the internet, and some of the greatest gains may

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[10]The archive has been acquired by Bill gates.

still lie ahead).[11]

Nobel-prize winner Robert Fogel has systematically summarized the improvements in longevity and health over the last three centuries, and forecast the possibilities for the century to come, in his 2004 monograph *The Escape from Hunger and Premature Death, 1700-2100*. More recently (2005), he has presented some of the main messages of the book in a briefer, more accessible, and more vivid form. In his 2005 essay he compares the health experiences of three cohorts, those born between 1835-1845, 1920-1930, and 1980-1990. The first cohort was roughly the cohort that fought the Civil War, the second cohort was roughly the cohort that fought World War II and the third cohort was roughly the cohort of today's college-aged students. Roughly 40% of the Civil War cohort died before the age of 15, compared with roughly 11% of the World War II cohort and roughly 1% of the college-aged cohort. Fogel describes life for the Civil War cohort as being not only short, but also nasty, as compared with the World War II cohort. Even when they survived, the cohort suffered from a variety of chronic and debilitating illnesses and conditions. Of those who survived to their late 30s, more than half were disabled. Large numbers suffered and died from malaria in the South and from tuberculosis in the cities. Chronic malnutrition was common.

Many more of the World War II cohort survived to old age, and of those, "the overwhelming majority have good to excellent health, live independent lives, and are socially active" (7). Fogel attributes the improvements to what he (and Dora Costa) call "technophysio evolution," which has resulted from "a synergism between technological advances and physiological improvements" (7). Some examples he emphasizes include the chlorination of water, the pasteurization of milk, and the elimination in cities of diseases spread by pulverized horse

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[11]This case has been made in Thomas Friedman's *The World is Flat*, and in several papers co-authored by Brynjolfsson (e.g., Brynjolfsson and Hitt, 2000).

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Extrapolating current trends, Fogel forecasts that the median life span for the current college-aged cohort will be roughly 100 years. But there is nothing inevitable in this; if institutions change to slow or quicken the rate of technophysio evolution, progress in increasing the lifespan will likewise slow or quicken.

There have been substantial improvements in the variety and characteristics of goods available in the last 100 years, as illustrated by the Rockefeller story, as sketched by DeLong, and as elaborated by Fogel. The most basic change has been in health, but there have been other basic changes as well, e.g., the richest person on earth could not have bought an air conditioned home in 1900.

Evidence for the 'Small-is-Better' Account of Creative Destruction

The 'big-is-better' account has been shown to not generally be true. Referring to this version, Scherer reports that in his substantial 1965 empirical study:

> The results suggested that Schumpeter's assertions in *Capitalism, Socialism, and Democracy* were more wrong than right. Giant monopolistic corporations were not uniquely efficacious engines of technological advance. (2005, 394)

Also relevant is the Acs and Audresch (1990) research showing that optimal firm size for innovation significantly varied by industry. Most notably, Christensen and his co-authors (2000, 2003, 2004) have presented substantial theory and evidence of how hard it is for an incumbent firm to successfully introduce a disruptive innovation.

The evidence of rapid and increasing turnover among the largest, most powerful, firms, by various measures, is evidence that supports the 'small-is-better' account of creative destruction. This evidence would include that discussed in Foster and Kaplan's *Creative*

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Destruction, in Zook and Allen's *Profit from the Core*, and in *Stall Points*. Also, and perhaps most powerfully, the evidence and theories in a variety of books, articles and case studies by Christensen and co-authors, support the 'small-is-better' account.

A common form of evidence for the small-is-better account consists of data showing how hard it is for large dominant firms to remain large and dominant for an extended period. One good source for this sort of data is Foster and Kaplan's *Creative Destruction*. For example, they examine the fate of the firm's in *Forbes'* 1917 list of 100 largest firms. By 1987, 61 of these firms no longer even existed. And of the 39 that still existed, only 18 were still among the largest 100. Figure 1 lists these 18 firms. Of the 18, only two had a growth rate in 1987 that was higher than the average for U.S. firms.

Foster and Kaplan also present evidence in their book (11) that in 1998 the turnover rate of the S&P 500 was approximately 10%, implying that the average firm could expect to remain in the S&P 500 for only approximately 10 years. This contrasts with a turnover rate of about 1.5% in the 1920s and 1930s—a rate that implies an expectation of a roughly 65 year average tenure in the S&P 500. The declining length of tenure in the S&P 500 might be evidence to support the claim of some (e.g., Greenspan; see Useem, 2001) that the process of creative destruction has been speeding up in the United States. The increasing pace of creative destruction is also independently supported in Chun, Kim, Lee and Morck, 2004.

Figure 2 from the Corporate Strategy Board is part of an extensive report that the Board presented to its large-scale corporate clients, documenting how hard it has been for large companies to maintain credible growth records. Zook and Allen (2001, 12) also provide additional evidence of how hard it is for large firms to sustain growth.

Besides evidence of the frequency and speed with which firms grow, and decline, another sort of evidence for the growing ubiquity of creative destruction in the United States economy is provided by the

**Figure 1. Of 18 Out of 100 Who Remained in Largest 100, All But Two Underperform U.S. Average Growth**

(Reproduced from: Foster & Kaplan, 2001 8)

Long-Term Survivor Performance

Growth in Market Capitalization CAGR 1917–1987, %

Company	Value
General Electric	7.8
Eastman Kodak	7.7
DuPont	7.2
Sears, Roebuck	6.9
Ford Motor	6.9
General Motors	6.9
Exxon	6.9
Procter & Gamble	6.7
Amoco	6.5
Westinghouse Electric	6.0
Chevron	5.9
Mobil	4.8
Texaco	4.7
Pacific Gas & Electric	4.2
Citibank	3.9
Southern California Edison	3.3
AT&T	2.8
USX	2.1

Long Term
US Average
7.5%

Source: *Forbes*, July 1987

Figure 2: Few Companies Sustain Growth
(Source: *Stall Points*, 1998, p. 15, as reproduced in:

http://www.csfb.com/home/research_and_commentary/html/docs/3096848.pdf

Exhibit 3: Average Annual Growth Rate for Companies Entering Fortune 50
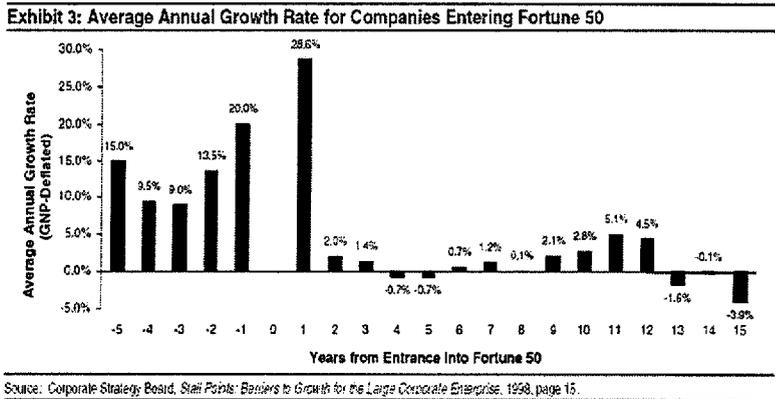
growing list of well-documented, or at least plausible, recent examples. One of the richest sources of such recent examples would be a set of three recent books authored, or co-authored, by Clayton Christensen (2000, 2003, 2004).

On May 11, 2004 among the 2,866 books on Amazon.com's "Search Inside the Book" feature that reference Schumpeter, the number-one bestselling book was Christensen and Raynor's *Innovator's Solution*. Like Schumpeter, Christensen had early experience in business, serving as chairman and president of Ceramics Process Systems Corporation. His earlier book, *The Innovator's Dilemma*, was widely acclaimed, receiving the *Financial Times'* Global Business Award for being the "best business book" for 1998.

The "dilemma" in Christensen's *Innovator's Dilemma* belongs to the incumbent firm.[12] Christensen distinguishes between two sorts of innovations. Sustaining innovations are innovations that will be valued by the incumbent firm's mainstream customers. The incumbent firm will pursue sustaining innovations, generally with success. The dilemma arises with the disruptive innovations. Disruptive innovations initially do not appeal to the mainstream customers of the incumbent firm. They frequently are too small, or to slow, or otherwise underperform what the mainstream customers want.

Christensen's most extensive example in the first book discusses successive generations of hard drives. The initial 5.25-inch hard drives did not have the capacity that mini-computer users wanted, so they had no interest in them. When the 8-inch drive companies listened to their mini-computer manufacturer customers, they saw no reason to develop the 5.25-inch drives. But there was a small niche market among personal computer users, who valued the 5.25-inch drives because of their small size. Start-up firms pursued this niche market and improved the technology over time, until it was increasingly competitive along all dimensions, with the 8-inch drives. By then it was too late for the incumbent firms to master the technology fast enough and well-enough to compete with the start-ups. The same story was repeated with successive generations of hard drive technology.

The first book provides extensive documentation of the hard drive example, and significant documentation on a second example: mechanical excavators. Much briefer discussion of other examples is also included. In the second book, *Innovator's Solution*, written with Raynor, Christensen lengthens the list of examples, and elaborates the theory of how hard it is for incumbent firms to survive in the face of

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[12]An extensive literature exists suggesting that large firms may have problems innovating due to inertia and problems with their internal incentive structure. See, e.g., Berle and Means (1932); Henderson (1993).

disruptive innovations. Although good examples occur throughout the book, a particularly efficient compilation of many examples occurs in the table on pages 56-65. Some of the cases in the table that seem good candidates to be major examples of successful leapfrogging competition, would include the following. Minicomputer makers such as Digital Equipment, leapfrogged mainframe makers such as IBM. PC makers such as Apple and Compaq, leapfrogged minicomputer makers such as Digital Equipment. Dell's direct retailing model, leapfrogged the previously leading PC retailers, Compaq, HP, and IBM. Online brokers such as Ameritrade and Schwab leapfrogged traditional brokerages such as Merrill Lynch. Online travel agencies such as Expedia, leapfrogged bricks-and-mortar agencies such as American Express. Department stores such as Macy's and Marshall Fields, leapfrogged small shopkeepers. Discount stores such as Kmart and Wal-Mart, leapfrogged department stores such as Macy's and Marshall Fields.

Conclusions and Implications for Action

Although the evidence for the truth and importance of creative destruction is being increasingly accumulated and recognized, I argue elsewhere (Diamond, 2004) that the importance of creative destruction is not being very effectively communicated to a wider audience, nor is it being applied to relevant policy issues, such as antitrust. It is highly plausible that our rate of economic growth would increase if we adopted policies making our economy more open to creative destruction.[13]

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[13]As part of an argument that we can significantly increase the rate of economic growth through institutional change, Romer makes the case for optimism: "Given the limited state of our knowledge of the process of technological change, we have no way to estimate what the upper bound on the feasible rate of growth for an economy might be. If economists had tried to make a judgment as the end of the 19th century, they would have been correct to argue that there was no historical precedent that could justify the possibility of an increase in the trend rate of

Schumpeter's process of creative destruction states that technological advance is the main source of economic growth and improvements in the quality of life. It further states that a significant part of the incentive to produce leapfrogging innovations is the prospect of achieving monopoly profits. The original 'big-is-better' account adds the view that large incumbent firms are most likely to be the source of leapfrogging innovations. In contrast, the new 'small-is-better' account adds the view that small, new firms are most likely to be the source of leapfrogging innovations.

I have argued that the benefits of leapfrogging innovations are difficult to measure, but that recently progress is being made, mainly through the careful examination of particular cases, such as advances in lighting and the introduction of the internet. While case studies are accumulated and generalized, I argue that the openness of the American economy to creative destruction, and the associated high levels of economic growth, and living standards, support a presumption in favor of creative destruction as the essential fact about capitalism.

I also have discussed the evidence against the old 'big-is-better' version of creative destruction and in favor of the new 'small-is-better' version. I find that there is substantial and growing evidence that leapfrogging innovations are at least as likely to arise from small, new firms, as from old, large firms.

In future work, I plan to answer an important question that is neglected in the current paper: how big is the destructive part of creative destruction? Or put differently: how much are workers hurt? Cox and Alm (2003, and 2004 with Holmes) show some evidence that workers may actually benefit from creative destruction, in the sense that the jobs created are better jobs than jobs destroyed. But this evidence needs to be further analyzed. In the more distant future, an important

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growth of income per capita to 1.8% per year. Yet this increase is what we achieved in the 20th century" (Romer, 226).

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extension of the current research would be to construct an index of the economy's "openness to creative destruction," and then to empirically examine the relationship of such an index to measures of technological innovation and economic growth.

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