



# Entrepreneurs Creating the New Economy

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# ENTREPRENEURS CREATING THE NEW ECONOMY

## EXECUTIVE SUMMARY

- **The Entrepreneurial Economy.** The "new economy" is based on rapid growth in high-tech industries and on new technologies reshaping manufacturing, finance, medicine, and other sectors. Entrepreneurs are the main force behind these revolutionary changes because they start the companies that create new technologies and they harness new technologies to improve performance across the economy. The new economy is an entrepreneurial economy.
- **Creating New Industries.** Entrepreneurs have created whole new industries by experimenting in market niches that were overlooked by established firms. New firms were instrumental in the introduction of electricity, the internal combustion engine, automobiles, aircraft, electronics, petroleum, plastics, and more recently personal computers, biotechnology, and the Internet.
- **Tackling Uncertainty.** In today's fast-moving economy, technological and market uncertainty are pervasive. Established companies or government agencies are not able to implement detailed plans to secure our economic future. Instead, the economy needs a diversity of established and new firms pursuing competing strategies and responding flexibly to changing conditions.
- **Generating Competition.** Industries that provide poor service, charge high prices, or fail to innovate create opportunities for entrepreneurs. In fact, new business formation provides a fundamental competitive check in the economy. In many industries, competition has intensified as new firms have been fueled by the rapid expansion of the venture capital, high-yield bond, and initial public offering markets.
- **Acting as the Economy's Guinea Pigs.** The market economy is a learning machine with the creative actions of entrepreneurs providing a crucial source of new and valuable knowledge. Entrepreneurs with radical new products or production processes are often doubted, even derided. However, the recent success of innovative firms such as Qualcomm and Celera Genomics shows that entrepreneurs continue to make breakthroughs by taking bold and untried new paths.
- **Turning Inventions into Innovations.** Entrepreneurs are the link between inventions and markets. They connect new products to consumer needs through a trial-and-error process. This role may be more important to economic growth than the initial generation of inventions. And it may also be more difficult because entrepreneurs often face restrictions, entrenched monopolies, and other barriers to introducing new and beneficial products and processes.
- **New Horizons.** Many formerly stagnant and monopolized industries have been opened up and transformed by entrepreneurs in recent decades. Building on this experience, policymakers may want to consider whether entrepreneurs could add value to industries still operated as monopolies, such as postal delivery and the public school system. If permitted to experiment, entrepreneurs may stumble upon many yet unknown innovations to improve quality and efficiency.

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**Prepared by Chris Edwards, Senior Economist to the Chairman.**

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## I. INTRODUCTION

America's robust economic expansion and booming technology sector are creating a "new economy." The new economy is based on rapid growth in high-tech industries and on high-tech industries reshaping the rest of the economy. High-tech gurus say that the "Internet changes everything." Indeed, computers and the Internet are spurring big changes in manufacturing, trade, finance, medicine, scientific research, and many other fields.

Entrepreneurs are the main force behind these revolutionary changes. Entrepreneurs start the companies that create new technologies and they harness new technologies to cut costs and improve quality in every industry from book sales to scrap steel trading. The new economy is an entrepreneurial economy.

Established businesses are responding to the intense competition from new entrepreneurial companies with restructuring efforts and large technology investments. However, in recent decades new companies have time and again caught established firms off guard. Young and fast-growing "gazelle" companies, such as Cisco, Amazon, Sun, Qualcomm, and Yahoo have been the pioneers behind many new products and industries. The competitive playing field has been leveled between new firms and large, established firms that were once thought to hold all the advantages.

From the introduction of its personal computer in 1982, IBM seemed destined for long-term domination of the PC market. But IBM would be eclipsed by a new company, Compaq, founded in 1982 by a partnership of three computer industry managers.<sup>1</sup> The new company raised \$87 million from the venture capital and stock markets enabling it to quickly compete on a large scale. Compaq's innovative computer allowed it to earn \$111 million in first-year sales - a U.S. business record. Compaq eclipsed IBM in personal computer sales in 1993, and became the world's largest PC maker in 1995.<sup>2</sup> This sort of bold challenge, and rapid growth fueled by plentiful risk capital, is the mark of the new entrepreneurial economy.

Success stories like Compaq's have put entrepreneurs on the front page of every magazine, spurred thousands of Americans to launch start-ups, and stimulated new interest in academia about the economic role of entrepreneurs. There are now hundreds of professors specializing in entrepreneurship in the nation's business schools, and student interest has soared.<sup>3</sup> College graduates have been eschewing Wall Street and big corporations to instead launch or join small high-tech start-ups.<sup>4</sup>

New business creation is at high levels. Over two million Americans start businesses each year, up from perhaps half a million per year in the 1970s. While most will remain small mom-and-pop operations, a small share of start-ups will grow into titans. These gazelle companies are exceptionally important to the economy. One study found that these firms represent just 4 percent of all U.S. companies, but create 60 percent of all new jobs.<sup>5</sup>

Young entrepreneurial companies have been aided in their competitive challenges by advances in technology and by revolutions in U.S. financial markets. Cheaper and faster

computers, sophisticated software, and the Internet have allowed smaller ventures to gain the information advantages once held by large firms. Financial market innovations in recent decades have ensured that large pools of capital are available to risk-taking entrepreneurs. The venture capital, high-yield bond, and initial public offering (IPO) markets have funneled billions of dollars to new ventures allowing them to test new ideas and challenge entrenched firms.

In addition, high levels of uncertainty in today's fast-moving economy have opened windows of opportunity for entrepreneurs. Technology and markets often take unexpected turns to which established companies are unable to adapt. High levels of uncertainty have also been a bane for governments and gurus who once believed that they could successfully plan our economic future. The big technology strategies that were popular a decade ago have been given up as hopeless in the face of fast-moving and unpredictable markets. At the same time, the 1990s boom has highlighted the role of entrepreneurs in tackling uncertainty with diverse competitive strategies. A recent article in the *Harvard Business Review* noted:

... [the] road ahead is [not] without potholes and sharp curves. Some of the fastest, shiniest companies in today's economy may very well crash ... But that is what the new economy is all about – companies attacking the status quo and entrenched players, and experimenting to find new technologies that improve or replace earlier ones.<sup>6</sup>

This report discusses how entrepreneurs create economic growth by testing new ideas, tackling uncertainty, challenging established firms, and growing small market niches into new industries. Section II examines new venture creation and the role of the financial markets in supporting entrepreneurial companies; Section III looks at the prevalence of uncertainty in the modern economy; Section IV examines how entrepreneurs generate economic renewal and growth; Section V discusses entrepreneurial waves and the role of entrepreneurs in public policy change; and Section VI provides the study's conclusions.

## II. THE RISE OF THE ENTREPRENEURIAL ECONOMY

### A. New Venture Creation

Every society has entrepreneurial individuals who continually pursue new and creative paths. In the economic world, the primary role of entrepreneurs is to establish and grow new business enterprises. New businesses inject novel ideas and products into society, generate competition to ensure high quality products and low prices, and create new jobs to replace jobs lost in declining industries.

The past few decades have seen a flourishing of new business creation. The author of the leading textbook on entrepreneurship, Professor Jeffrey Timmons, estimates that U.S. business start-ups have grown from perhaps 200,000 per year prior to the 1970s, to about 600,000 by the mid-1970s, to well over a million today.<sup>7</sup> Figures from the National Federation of Independent Business show that there have been between 2.3 and 3.5 million new businesses launched in each of the past four years.<sup>8</sup> These swarms of start-ups have transformed the U.S. economy, pushed the unemployment rate down to 30-year lows, revived many formerly decaying towns, and powered an 18-year boom (1982-2000) with just 2 quarters of mild recession. In addition, the entrepreneurial boom has allowed millions of Americans to realize their dreams, as described by Professor Timmons:

Classical entrepreneurship means new venture creation. But it is much more ... it is arguably the single most powerful force to create economic and social mobility. Because it is opportunity-centered and rewards only for talent and performance – and could not care less about religion, sex, skin color, social class, national origin, and the like – it enables people to pursue and realize their dreams, to falter and try again, and to seek opportunities that match who they are, what they want to be, and how and where they want to live.<sup>9</sup>

With the rise of the entrepreneurial economy in recent decades, conceptions of the business sector have changed. Attention used to focus on the distinction between big and small businesses: big businesses were thought to be stable and control the most important industries, whereas small businesses were thought to be less stable and less important. But there is growing recognition that a more useful distinction is between established firms and new firms. Attention has focused, in particular, on "gazelle" firms, which are young firms that grow into big firms very quickly, such as Compaq or Cisco.

Gazelles are different from the millions of mom-and-pop businesses that start small and stay small. Gazelles grow big quickly, and often help create whole new industries. Economic historians Nathan Rosenberg and L.E. Birdzell note, "New enterprises, specializing in new technologies, were instrumental in the introduction of electricity, the internal-combustion engine, automobiles, aircraft, electronics, aluminum, petroleum, plastic materials, and many other advances."<sup>10</sup> That list can now be updated to include personal computers and PC software, the Internet, biotechnology, and other high-tech industries.

The United States has excelled at growing small firms into the new giants of leading-edge industries.<sup>11</sup> Efficient financial institutions, a huge domestic market, and the willingness of entrepreneurs to think big have allowed the United States to sprout thousands of gazelle companies. For example, start-up Cellular One beat giant Nynex and others in the emerging cellular telephone industry in the 1980s, and built a \$100 million business in five years, with no advantages other than entrepreneurial skill and smart marketing.<sup>12</sup>

This sort of success has been repeated many times in recent decades. The economic dynamism it is creating can be seen in the rapid turnover of the largest publicly-traded firms. For example, just 11 of the top 25 U.S. firms by market capitalization in 1989 remained in the top 25 by 1999.<sup>13</sup> Many of the newcomers to the top 25, such as Microsoft, Oracle, and Dell, have been led by determined entrepreneurs who are now among the wealthiest Americans. As a result, the American rags-to-riches success story is more common than ever. Research on America's millionaires has found that about 80 percent are self-made, while just 20 percent live off of inherited wealth.<sup>14</sup> Similarly, about 80 percent of *Forbes* magazine's 400 richest people built their wealth rather than inheriting it.<sup>15</sup>

The technology boom is generating great interest in entrepreneurship. The share of college students who are interested in starting businesses is up sharply.<sup>16</sup> Top university graduates have flocked to high-tech start-ups rather than big corporations, although recent stock market turbulence may temper this trend.<sup>17</sup> And as corporate America has restructured, many laid off managers have taken the opportunity to start new firms.<sup>18</sup>

As has been widely documented, the information technology revolution has leveled the playing field between large, established firms and new firms. Many Internet start-ups have successfully challenged older bricks and mortar companies. As a leading venture capitalist recently noted, "The Internet has lowered the barriers to entrepreneurship and democratized it for a wider populace."<sup>19</sup> The Internet provides everyone access to vast amounts of scientific, technological, and economic data. And as *Inc* magazine points out, the amount of information available on how to start and grow new businesses has increased greatly as well.<sup>20</sup> Even before the Internet, the PC revolution was already handing power to entrepreneurs. In the 1980s, PC database software, spreadsheets, word processing, and desktop publishing allowed small firms the tools they needed to compete with big firms.

Technology has become an entrepreneur's best friend in research and development (R&D)-based industries with the advent of more powerful and less expensive computers, lab equipment, software, and other tools. Since 1990, the share of the nation's industrial R&D spending by the largest companies (those with over 25,000 employees) has declined from 65 percent to 43 percent, as smaller company R&D has grown.<sup>21</sup> Empirical research has found an increased share of innovation coming from small firms in recent decades,<sup>22</sup> and some evidence indicates that the productivity of R&D is higher in small firms than large firms.<sup>23</sup>

Another factor that has made small firms more competitive is the rise in collaborative R&D between firms, and between firms and universities. A recent report by the OECD notes that such networking allows small firms "to combine the advantages of smaller scale and greater

flexibility with economies of scale and scope.”<sup>24</sup> Jay Walker, founder of Priceline.com, has summarized this trend:

... today and in the future, the Information Network will make the centralization of information and research far less relevant. For all information will be available on the network, readily commanded by individuals and companies of every type. Armed with fast, cheap, ubiquitous computing, process, and communications power, innovation will increasingly emerge not from a small number of large corporate entities, government agencies, and centralized research centers, but from individuals and much smaller organizations.<sup>25</sup>

## **B. Financial Innovation**

The current high-tech boom has highlighted the vital link between entrepreneurs and the nation’s capital markets. In a familiar story, promising young start-ups are sought out by venture capitalists and nourished with cash and management expertise. For firms that show promise of fast growth, public equity markets are tapped with an initial public offering (IPO) to raise more cash. Top talent is attracted with stock options and the firm is set for rapid expansion.

While the Internet frenzy has sped up this process, U.S. financial markets have a long history of funneling risk capital to entrepreneurial firms. Well-known inventors in prior centuries often teamed with wealthy financiers who could cover early losses during experimentation and fund quick expansion when bringing inventions to market.<sup>26</sup> For example, a century ago J.P. Morgan provided seed capital for Thomas Edison’s Edison Electric Illuminating Co. Edison’s speculative new business would expand to later become General Electric.<sup>27</sup> Risk capital was integral to financing the railroad and telegraph booms of the 1800s, and the radio, electricity, and automobile booms of the early 20th century.<sup>28</sup> So risk capital is certainly not new, but the vastly greater volume and efficiency of today’s financial markets allow many more potential Edisons to be funded.

The high-tech boom has been fueled by innovations in both the debt and equity markets. On the debt side, high-yield bonds played a key role in the 1980s in financing rapid growth in computers, semiconductors, telecommunications, and other industries. One estimate found that high-yield bonds financed 80 percent of the computer industry’s expansion in the late 1980s.<sup>29</sup> The decade’s most famous bond salesman, Michael Milken, raised over \$90 billion to finance expansion at MCI, McCaw Cellular, Viacom, Tele-Communications Inc. (TCI), Time Warner, Cablevision, News Corp., CNN, and hundreds of other growth firms.<sup>30</sup> Many of these companies could not have raised the large sums of money needed for expansion anywhere else.<sup>31</sup> Entrepreneurs like Craig McCaw of McCaw Cellular used debt to make large upfront investments in the hopes that the risks would be rewarded with big payoffs down the road.<sup>32</sup> *Business Week* noted that McCaw was “ridiculed” in the 1980s for making such big early investments in cell phones, but the market subsequently exploded and McCaw became the largest cell phone operator in the country.<sup>33</sup>

In a 1991 book on the high-yield bond industry, Glenn Yago describes how these instruments, "created access to capital for small and medium-size companies that had been economically disenfranchised from participating in the capital markets."<sup>34</sup> Yago notes that "investment grade" debt securities could only be issued by about five percent of the nation's largest publicly-traded corporations. Most small and medium-size corporations relied on high-priced and more volatile bank loans and equity finance, putting them at a significant funding disadvantage to big corporations. The growth in the high-yield bond market went a long way towards putting smaller companies on an equal competitive footing. The *Wall Street Journal* recently noted that enthusiasm for high-yield bonds is now spreading to Europe and Japan because it creates, "the democratization of capital ... allowing little people to compete with the big guys regardless of bond rating, nationality, or size."<sup>35</sup>

Consider Wall Street's role in backing the company that helped revolutionize U.S. telecommunications markets - MCI. Risk-taking venture investors put up tens of millions of dollars to back MCI in a decade of legal struggles with AT&T in the 1970s. With the court-ordered AT&T break-up in the early 1980s, MCI was on the cusp of a major expansion. Drexel Burnham Lambert helped MCI raise \$2 billion in a high-yield bond issue in 1983.<sup>36</sup> With this infusion of cash, MCI could now build a nationwide fiber optic network and drive down the cost of long-distance phone service.<sup>37</sup> Michael Milken could have been describing MCI when he noted that high-yield bonds, "allow entrepreneurs outside the system to get capital to realize their dreams."<sup>38</sup>

In addition to financing young growth companies, high-yield bonds have played a key role in remaking America's large, established corporations into a more entrepreneurial mold. In the early 1970s, a group at Bear Stearns led by Jerome Kohlberg experimented with a new technique of using high-yield debt to finance buyouts of poorly performing companies. The purpose was to install new management and improve performance for shareholders. A leveraged buyout (LBO) by Kohlberg's group in 1972 showed how the technique would work. Bear Stearns teamed with managers of a division of Singer Co. who believed they could run the division better as an independent company. Bear Stearns put up \$4.4 million and raised \$33.5 million in debt to acquire the division, and then installed the new management to make the needed changes.

Kohlberg, along with Henry Kravis and George Roberts, formed KKR in 1976 to specialize in such deals. KKR realized that many of the nation's diversified conglomerates would generate more value to the economy if they were split up and run separately. But KKR needed investment funds to realize their plans. Their timing was right, as they were able to tap into newly liberalized pension fund money in the late 1970s, and new high-yield bond financing structures pioneered by Drexel Burnham Lambert. With these new sources of capital, KKR and others jump-started the corporate restructuring boom of the 1980s.

The corporate shake-ups spurred by the LBO movement were controversial because some deals were bitterly fought, and some companies failed to climb out of a mountain of debt. But LBOs, and broader efforts to make corporate management more accountable, created widespread ripple effects on the economy. Managers in every corporation were forced to improve performance to avoid becoming the next takeover target. *Forbes* noted of the 1980s, "attitudes in

American business across the board had been changed by 2,385 leveraged buyouts worth a total of \$245 billion ... These deals helped revolutionize corporate finance, create new incentives for efficient management, and inspire risk-taking on a grand scale."<sup>39</sup>

In the 1990s, a second front of entrepreneurial financing blossomed with the explosion of the venture capital (VC) industry in Silicon Valley. This industry fed \$48 billion of equity risk capital to young technology companies in 1999, up from just \$3 billion in 1990. Since the 1970s, many of the dynamos of the U.S. high-tech industry were nourished with VC investment, including Apple, Lotus, Compaq, Intel, Yahoo, Sun, Genentech, Cisco, and Amazon.<sup>40</sup>

Like the debt-market innovators of the 1980s, VC financiers started out small and honed their craft over time with experimentation. They faced many unknowns that could only be answered with trial and error: How should VC investment vehicles be structured to limit risks? How many failed companies can be sustained for each winner? When should money-losing companies be folded? When should companies be brought public? Today, the VC industry is continuing to evolve. Attempts to speed the start-up process have led to the development of over 350 business “incubators” and “accelerators” such as idealab! and CMGI.<sup>41</sup> These entities co-locate a group of start-up firms together to share accounting, marketing, legal, and strategy expertise, so that entrepreneurs can stay focused on company-building.<sup>42</sup> Time will tell whether this assembly line approach to entrepreneurship will work.

Other innovations include experiments by some venture funds to open up investment pools to ordinary investors. Typically, only institutional investors and wealthy individuals took part in VC funding for various reasons including regulatory roadblocks.<sup>43</sup> If these experiments are successful, it should further increase the flow of money to leading edge firms in the economy.<sup>44</sup> As the flood of investment capital into venture funds increases, the nature of VC funds may also evolve since what worked when the industry was small may not work so well when it is big.<sup>45</sup> Again, only time will tell.

The success of financial markets in funding America's entrepreneurial boom is summed up by a recent *Harvard Business Review* piece that noted, “Money in this country flows toward big dreams.”<sup>46</sup> Those big dreams, and access to cash, will continue to fuel competitive challenges, the development of new industries, and the generation of growth and renewal in the economy.

### III. UNCERTAINTY AND THE LIMITS TO PLANNING

The growth of the economy during the past two centuries has been characterized by many dead ends, bankruptcies, disappeared industries, and failed prognostications. Professor Richard Nelson summarizes what we are up against in planning for the future:

The batting average of scientists and engineers, economists, government officials, and businessmen in predicting the most important future technological events has been abysmal. Experts very often are wrong both in what they predict will happen, and in what they predict won't happen.<sup>47</sup>

Consider the track record of experts in macroeconomic projections. *Business Week's* annual outlook poll in December 1998 concluded that, "In uncommon unity, forecasters from all around the country expect growth to slow, perhaps substantially."<sup>48</sup> The magazine found that, on average, 55 leading economists predicted that real GDP growth in 1999 would be 1.9 percent. As it turned out, 1999 was a banner year with growth coming in at 5.0 percent. *Business Week's* surveyed experts made the same mistake the year before by predicting real growth of 2.3 percent for 1998. Actual 1998 growth came in at 4.6 percent.<sup>49</sup>

Projections regarding particular markets or technologies have been no better. History is full of examples of new technologies that were at first greatly over or underestimated, such as the telegraph, telephone, and personal computer.<sup>50</sup> Innovation expert Clayton Christensen concludes that we "can always count on one anchor: experts' forecasts will always be wrong."<sup>51</sup> Today, the economy is more dynamic and unpredictable than ever due to deregulation, globalization, and the information technology revolution. These forces have eroded the ability of experts to make predictions, and eroded the ability of governments and big corporations to control the pace or direction of economic change.

This is the type of environment that entrepreneurs thrive in. High levels of uncertainty tend to give the edge to small and new companies.<sup>52</sup> This is not because they can prognosticate any better than large firms. In fact, studies have not found any correlation between start-up success and prior extensive planning.<sup>53</sup> Instead, the small-firm advantage is the ability to change direction quickly as markets change, and the sheer numbers of small firms means that some will succeed even if many fail. Small-firm flexibility is exemplified by the fast-changing Internet industry, where businesses "launch and learn" rather than adhering to long-range strategies. A good example is the launch of Netscape in 1994 which made the early decision to give away its Navigator Web browser for free. Where would Netscape's revenues come from? The company founders thought that they would figure that out later.<sup>54</sup>

The following sections underscore the fact that neither businesses, governments, nor the gurus can plan our economic future very accurately. Past errors in judging technology and markets are cataloged. As discussed later in the report, this great uncertainty is a fundamental reason why the economy needs a diversity of entrepreneurs to tackle every new opportunity. No company or expert will always get it right.

## ***Business Plans and Predictions***

- **Interactive TV.** Before consumers embraced the Internet by the millions, technology pundits and big companies were betting on "interactive TV," which would feed movies and other services to home TV sets on demand. In the early 1990s, Time Warner and others invested hundreds of millions of dollars developing and installing prototypes in test communities.<sup>55</sup> But the explosion of the World Wide Web in 1994 and 1995 made it suddenly clear that this approach was all wrong. It turned out that the information superhighway would be based on PCs, not TV sets. In a rapid about-face, every big player changed direction - Microsoft famously realized the importance of the Internet all of a sudden in 1995, and quickly moved 1,000 programmers into Internet projects.
- **HDTV.** A few years before interactive TV, high definition television (HDTV) was the big new thing. In 1992, the *Journal of Commerce* reported, "Businessmen and scientists believe that HDTV ... will be the invention that drives the next major technological revolution, creating an explosion of consumer demand to fund a generation of industrial growth and innovation."<sup>56</sup> Almost a decade later, that revolution still has not happened.
- **Iridium.** As the cell phone industry was taking off, \$5 billion and 10 years of work were pumped into developing a satellite-based phone system, Iridium, that could be accessed worldwide. Iridium was backed by a leading technology company, Motorola, and the complex technology for the system was successfully developed. However, the market for the expensive phone system did not materialize as expected. Iridium filed for bankruptcy in 1999, and pulled the plug on its network in March 2000, after operating less than two years.<sup>57</sup>
- **Satellite TV.** Unlike Iridium's satellite phone experience, satellite TV has been very successful - to the surprise of many pundits who didn't think it made sense. The *New York Times* reports that people had originally joked that Hughes' DirecTV DBS system stood for "Don't Be Stupid."<sup>58</sup> But now Hughes's satellite system has eight million viewers, making it larger than all but two of the nation's cable TV systems.
- **Computers.** Huge under and overestimates have plagued the computer industry since its inception. In the 1950s, IBM developed computers for military and scientific applications, but totally discounted possible business applications.<sup>59</sup> As it turned out, its first "Model T" computer, the 650, sold nine times more units than projected as businesses snapped up the machines for uses like payroll that IBM had overlooked.<sup>60</sup>

On the other hand, IBM and other mainframe manufacturers missed out on the later mini-computer market, which became populated by new firms such as Data General and Digital Equipment Corporation (DEC). Then in turn, both the mainframe and minicomputer makers overlooked the PC market, which was pioneered by start-ups such as Apple.<sup>61</sup> Ken Olsen, founder of DEC, in 1977 noted, "There is no reason for any individual to have a computer in their home."<sup>62</sup> Then in the 1980s, new firms, such as

Compaq and Sun, pioneered the markets for portable computers and engineering workstations, respectively. Finally in the 1990s, Dell eclipsed Compaq in the U.S. PC market by use of a new business model – Internet sales. Similarly, the computer games market was missed by all the existing computer firms, and instead pioneered by Atari in the early 1970s. Atari's founder, Nolan Bushnell, remembers, "People thought the idea of playing games on a television set was the stupidest idea they'd ever heard of."<sup>63</sup>

- **Synthetic Leather.** After their huge success with Nylon, Dupont spent \$100 million in the 1950s and 60s developing and marketing a synthetic leather substitute. Thorough research, trials, and market studies were completed, and a product was launched with a big advertising campaign. But the product failed and was eventually withdrawn from the market.<sup>64</sup>
- **RCA's VideoDisc.** RCA introduced a videodisc player in 1981 with projections that sales would rise into the billions of dollars as the machine substituted for the VCR. Unfortunately, the product was a flop, and the company lost over half a billion dollars by 1986.<sup>65</sup>
- **Other Misjudgments.** There are many other famous misjudgments by leading businesspeople. Edison had that thought battery cars were the future.<sup>66</sup> Bill Gates in 1981 thought that, "640K [of computer memory] ought to be enough for anyone." And IBM's chairman in 1943 opined, "I think there is a world market for maybe five computers." The *Economist* cites the U.S. Patent Commissioner stating in 1899 that, "Everything that can be invented has been invented," and notes that, "History is littered with such foolish predictions about technology."<sup>67</sup>

Based on their study of two centuries of industrial innovations, Professors Chris Freeman and Luc Soete think that projections for new products are often wildly over or underestimated, and no company is immune to big blunders.<sup>68</sup> The authors note, "The power of the giant corporation should not be exaggerated ... it is clear that many attempted innovations fail in large firms as well as small firms."

Such failures are often fatal and the graveyard of once high-flying technology companies is very large. All is not lost to the economy though. Workers from failed companies take their knowledge to newer companies, and the best innovations will be borrowed by surviving firms like successful adaptations in an ecosystem.

### ***Insights of the Policy Gurus***

If technology companies cannot accurately project the future, it seems unlikely that policy gurus can do any better. However, that doesn't stop the gurus from trying, as illustrated by some of the bad advice given to the U.S. high-tech industry over the years. Such misjudgments can lead to public policy that over-reaches the government's abilities, and locks the economy into faulty and wasteful outcomes.

- **Too Many Entrepreneurs.** A decade ago, many leading gurus concluded that Japan's government "planning" had put its economy in the lead. They also thought that the United States had too many entrepreneurs following different plans, rather than one overall national strategy. In 1988, *Time* magazine reported, "many scholars and business leaders ... are beginning to voice concern about what Harvard economist Robert Reich has dubbed 'chronic entrepreneurialism'."<sup>69</sup> *Time* went on to note, "They blame the proliferation of small companies for an alarming loss of U.S. market share in strategic high-tech industries, ranging from semiconductors to fiber optics. The constant sprouting of new ventures, they explain, may be weakening the U.S. industrial structure by splintering American manufacturing power into too many small pieces."<sup>70</sup> Today, it is clear that these concerns were widely off target. But some pundits don't give up, and have recently been lamenting that there is now too much venture capital.<sup>71</sup>
- **More Planning Needed.** More technology "planning" seemed to make sense to many in the 1980s and early 1990s. In 1992, former chairperson of the Council of Economic Advisors, Laura Tyson, noted, "We must not be hoodwinked by the soothing notion that the fate of America's high-technology industries will be determined by market forces."<sup>72</sup> Such sentiments were common.<sup>73</sup> A major 1989 study by the blue-ribbon MIT Commission on Industrial Productivity captured the optimism regarding government technology planning: "[The Japanese semiconductor] business is coordinated by the government to minimize wasteful duplication of effort..."<sup>74</sup> By contrast, the U.S. needs "structural rationalization" for its "existing inefficient system" of production.<sup>75</sup> But during the 1990s, the U.S. high-tech industry surged as a result of individual entrepreneurial efforts, and Japan has had a decade of slow growth.
- **U.S. High-Tech Sector Too Fragmented.** The 1989 MIT report lamented the "fragmentation" of the U.S. semiconductor industry compared to the more "rationalized" Japanese industry.<sup>76</sup> The report found that, "a pattern of instability, high mobility, and new-venture formation has characterized the young American merchant [semiconductor] industry in the past 20 years." By contrast, "The Japanese semiconductor industry was far more stable," which is, "more important than ever."<sup>77</sup> Similar criticisms were aimed at the U.S. computer hard-drive industry.<sup>78</sup>

Again, these experts were exactly wrong. Diversity and "fragmentation" were the keys to the remarkable resilience and continuing rapid growth of Silicon Valley, as documented in Annalee Saxenian's excellent 1994 study of the region.<sup>79</sup> While the U.S. semiconductor industry did face heavy competition in the 1980s, its share of the world market has risen from 37 percent in 1989 to 51 percent today.<sup>80</sup>

- **Short-Term Time Horizons.** It used to be widely claimed by economic gurus that long-term time horizons were another key to Japanese success. The 1989 MIT report criticized the "short time horizons" of U.S. businesses and their "bias toward quick profit."<sup>81</sup> Wall Street's efforts to pressure corporations to maximize short-term performance was widely criticized. Pundits claimed that the Asian and Continental European models of interlocking corporate ownerships gave companies more room for long-term planning. Prominent economics guru Lester Thurow thought it was a good

thing that in Japan and Germany, “Business groups insulate management from short-term stock market pressures.”<sup>82</sup>

But today, America's supposed vices like short corporate time horizons sound more like virtues, notes economist Paul Krugman.<sup>83</sup> The Asian and European business models had major flaws and have been exposed as "crony capitalism." These countries are now moving towards American-style corporate structures.<sup>84</sup> Long-term planning is out, and the rapid exploitation of new ideas is in, as companies today compete in “Internet time.”

- **Lifetime Employment Policies.** A decade ago, many experts were promoting Japanese-style “lifetime employment” policies as a key to economic success. Lester Thurow thought that America’s compensation policies should be changed to “dramatically cut turnover rates” and reduce job-hopping by business managers.<sup>85</sup> The 1989 MIT report thought that Japanese employment policies gave them the edge: “Independent venture formation and mass defections are almost nonexistent in the Japanese semiconductor industry.”<sup>86</sup> It suggested, “Policies should encourage structural rationalization, less personnel turnover, and more training,” and that, subsidies be given to companies to “encourage long-term employment.”<sup>87</sup>

Once again these prescriptions appear to have been exactly wrong. With lifetime employment, Silicon Valley would simply not exist because it was built by job-hopping engineers founding start-ups, often with borrowed ideas that prior employers weren’t interested in. Job-hopping has led to the rapid diffusion of new ideas in Silicon Valley.<sup>88</sup> Consider Larry Ellison who moved from firm to firm in Silicon Valley in the 1970s waiting to seize an opportunity. He found it in the late 1970s in IBM's idea for relational database software. As IBM wasn't pursuing the idea, Ellison founded Oracle to pioneer database software, and has grown it into the world's second largest software firm today.<sup>89</sup>

The Silicon Valley tradition of job-hopping engineers began with the exodus from Shockley Semiconductor in 1957, which included Gordon Moore and Robert Noyce. Moore and Noyce went on to lead Fairchild Semiconductor and grow it into a dominant Silicon Valley firm in the 1960s, before jumping ship again to found Intel in 1968. Fairchild was such a great incubator of future engineer-entrepreneurs that at least 100 Valley companies were founded by these “Fairchildren.”<sup>90</sup> Similar patterns are found in other high-tech industries, including scientific instruments<sup>91</sup> and disk drives.<sup>92</sup> Silicon Valley has twice the job mobility rate of the U.S. economy as a whole.<sup>93</sup>

These types of bad policy calls in the past have now made most economic gurus more cautious about promoting big strategic plans.<sup>94</sup> Governments, as well, have been humbled by their failed white elephant technology projects, and by their inability to effectively carry out strategic planning. While governments do need to get the basics right in areas such as education and tax policy, there is simply too much uncertainty for detailed strategic planning to be done effectively, as the following section illustrates.

## ***Government Strategic Planning***

- **MITI.** Japan's technology planning agency, MITI, used to be held out as a model of farsightedness in industrial policy. Lester Thurow, for example, thought, "Japan Inc needs to be met with USA Inc" because "major investment decisions have become too important to be left to the private market alone."<sup>95</sup>

But, as now widely documented, MITI's crystal ball was never any better than anyone else's. For example, MITI advised Honda to stick to motorcycles and not diversify into cars; it encouraged over-investment in steel and aluminum; its heralded "fifth generation" computing initiative in the 1980s was a failure;<sup>96</sup> it discouraged Akio Morita, founder of Sony, from licensing transistor technology from the United States in the early 1950s;<sup>97</sup> and in the 1960s, it mistakenly advised the car industry to consolidate.<sup>98</sup>

If MITI wasn't so great at "planning," what explains Japan's industrial success up until the 1980s? Japan succeeded because of high levels of competition and entrepreneurship, not industrial policy, as George Gilder and others have noted.<sup>99</sup> Many Japanese industries, including automobiles, motorcycles, steel, robotics, and consumer electronics had high numbers of firms leading to a diversity of strategies and intense domestic competition.<sup>100</sup> By the 1990s, the failure of industrial planning had led even MITI to change its focus, and it now promotes deregulation rather than centralized planning.<sup>101</sup>

- **Antitrust.** Many economists support antitrust policy because it has theoretical appeal and seems to make sense in the static world of paper calculations. But antitrust's Achilles heel is that the real economy is highly dynamic, thus often making government solutions obsolete before the legal ink has dried. Consider the antitrust case against Xerox in the early 1970s. After inventing the first modern photocopier in 1960, Xerox Corporation led the industry it created for the next decade, and still held an 86 percent market share in the early 1970s. In 1973, the Federal Trade Commission charged Xerox with illegally monopolizing the copier business. A two-year struggle with the FTC costing millions of dollars ended in a settlement. As it turned out, the government's intervention proved to be unneeded as IBM, Eastman-Kodak, Canon, Minolta, Ricoh and others surged into the market in the mid-1970s with often superior products. As new competitors arrived and Xerox's management energy was drained by litigation, their market share was eroded to just 54 percent by 1978, and continued to fall.<sup>102</sup> Dynamism in the economy also made redundant other high profile antitrust cases such as the federal government's 1969-1982 losing case against IBM's mainframe computer business. This case cost hundreds of millions of dollars, generated 66 million pages of evidence, sapped IBM's management resources, and ended up after 13 years with the government conceding that its case was without merit.<sup>103</sup>
- **Alternative Fuel Cars.** A recent example of misjudgment in technology policy appears to be the current administration's efforts to spur development of alternative fuel cars with over \$1 billion of financial support to national labs and U.S. automakers. The *New York Times* has reported that while U.S. carmakers are far from introducing a marketable product, Japanese producers already have such vehicles that they developed with little

government funding.<sup>104</sup> U.S. makers have focused attention on diesel hybrid engines, which so far appear to have been a poor choice, compared to the gasoline hybrids the Japanese companies opted for.

- **Big Technology Projects.** While the U.S. government has been more restrained than other governments in pursuing big civilian technology projects, it has pumped money into its share of white elephants. During the 1960s, the U.S. and European governments each spent billions of dollars developing competing supersonic passenger airplanes. The U.S. program was cancelled in the early 1970s, but the European Concorde did not succeed as planned either. The *Financial Times* recently noted that the Concorde was too expensive, far over budget, too cramped, too noisy, and ended up being a \$13 billion taxpayer subsidy to the wealthy.<sup>105</sup> Other white elephant projects in the U.S. include many in the energy field, such as the \$2 billion wasted from 1970-1984 trying to produce synthetic fuel from coal.<sup>106</sup>

### ***Even Successes Are Often Not Planned***

While economic plans and predictions often fail, even successes are frequently not fully expected. For example, some of Japan's management innovations were more chance developments than far-sighted policies. Professor Nelson notes that Japan's just-in-time manufacturing innovations originally stemmed from space shortages in factories; only later were they found to also facilitate quality control.<sup>107</sup> Another example is Henry Ford's famously high worker pay. It is often claimed that this policy stemmed from an enlightened and far-sighted social policy by Ford. In fact, the policy stemmed from unanticipated high factory turnover, which reached 400 percent, when Ford introduced his moving assembly line.<sup>108</sup> Ford discovered that he had to pay high wages to retain skilled workers so that his new system would work.

Some successful entrepreneurs admit that they never expected their innovations to have such a big impact. The co-founder of Adobe Systems, Dr. John Warnock, has noted, "Those of us who started the desktop computer and software revolution almost 20 years ago had no idea what an impact our ideas would have on the economy and society."<sup>109</sup> In Adobe's case, "we imagined that one day if we were successful, we might employ around 40 people ... fortunately for us, our rather modest business plan did not work out the way we had predicted." Today, Adobe is the third largest PC software company in the U.S. with revenues of \$1 billion and a workforce of 2,600 people.

### ***Implications***

The last few sections documented how businesses, governments, and experts can all seriously misjudge the future course of technology and markets. How then should the economy be organized to deal with such ubiquitous misjudgment and failure? The balance of the report describes how an entrepreneurial economy succeeds by generating a diversity of new and growing firms to experiment and compete, particularly in leading-edge industries where uncertainty is the greatest.

The venture capital industry illustrates one of the ways an entrepreneurial economy deals with uncertainty. One estimate found that about half of VC investments are write-offs.<sup>110</sup> And only a few VC investments are big successes: just 7 percent of venture investments account for about 60 percent of profits, according to estimates.<sup>111</sup> VCs and their investors are able to take on risky projects by diversifying their portfolios and knowing when to cut losses. By contrast, large corporations are often not willing to try risky experiments, as discussed in later sections.<sup>112</sup>

In addition, smaller, entrepreneurial companies have a better ability to correct for misjudgments because of their greater flexibility. In fact, entrepreneurs typically change plans frequently after they launch start-ups.<sup>113</sup> As a general rule, large corporations are not so flexible. As a result, smaller firms tend to populate highly uncertain markets, while large corporations tend to populate more stable industries, although other factors do come into play in determining industry structures. A continuum can be envisioned with entrepreneurial economies at one end structured around a diversity of nimble firms competing with flexible strategies.<sup>114</sup> At the other end are government-led economies following overarching industrial strategies. Economies resembling the latter are much more vulnerable to unexpected events, and are slower to take advantage of growth opportunities when they arise, than are entrepreneurial economies.

Government policy can support the entrepreneurial economy by removing barriers to business start-ups and expansions, and by opening doors to competition in every industry. In addition, government itself should act in a stable and predictable manner so that entrepreneurs do not face political uncertainties on top of the uncertainties they face in the marketplace.<sup>115</sup>

## IV. WHAT DO ENTREPRENEURS DO FOR THE ECONOMY?

### A. Entrepreneurs in Economic Theory

The creative actions of entrepreneurs are central to economic growth, but entrepreneurs have received little attention from mainstream economic theory. Economics textbooks generally say little about the growth of small firms into the giant corporations of tomorrow. Professor William Baumol has noted that entrepreneurs did make "shadowy" appearances in 19th century economics, but these shadows largely disappeared in the 20th century.<sup>116</sup>

A principal reason for this disappearance is that much of modern economics focuses on mathematical abstractions within which entrepreneurial actions do not fit well. The central focus of mainstream, or "neoclassical," theory is "general equilibrium." In general equilibrium, the economy is at rest, no firm earns exceptional profits, labor and capital usage is optimized, and producers and consumers act with complete certainty. These elements are expressed in precise mathematical models that leave no room for the often anarchic and messy acts of entrepreneurs. By leaving out entrepreneurs, mainstream economics provides us with "an elaborate stage of theory, without a protagonist to animate the play," notes George Gilder.<sup>117</sup>

The marginalization of entrepreneurship in economic theory causes problems when real world public policy issues are examined.<sup>118</sup> On the one hand, mainstream theory provides accurate insights for simple policy issues, such as the effect of price controls on an industry. But it does a poor job explaining more complex issues, such as the causes of economic growth. This is because the chief "protagonist" of economic growth, the entrepreneur, has been left out.

By leaving out the entrepreneur, mainstream theory also biases public policy towards focusing on the market economy's shortcomings, rather than its achievements. For example, theory posits that "market failures" occur when markets don't live up to a textbook definition of perfection. In the idealized perfect economy, consumers and producers act like robots with perfect foresight and optimal decision-making. Alas, the real economy is plagued with uncertainty and people make many imperfect decisions. In such cases, theory suggests that the market has failed, and many economists presume that corrective government action becomes required.

Ironically, by leaving out entrepreneurs mainstream economic theory leaves out the problem solvers who tackle the very imperfections that theory has identified. For example, consumers do indeed lack perfect knowledge about many products, and as a result are sometimes fleeced in the marketplace. But entrepreneurs invent mechanisms to counter these problems such as brand names, warranties, insurance, and other devices. In recent years, Internet entrepreneurs have created a huge leap forward in consumer knowledge by providing online information about product pricing, quality, and safety.<sup>119</sup>

Numerous economists have recognized the shortcomings of mainstream economic theory, and devoted attention to the crucial role played by entrepreneurs. The following bullets highlight

some of the views of various economic thinkers regarding the functions performed by entrepreneurs. Particular real world entrepreneurs may be thought of as performing some combination of these functions.<sup>120</sup>

- **Coordinate Production.** Some economists, beginning with Jean-Baptiste Say, have described entrepreneurs as the coordinators of the factors of production. In this role, the entrepreneur rents the factory, hires labor, purchases inputs, and serves customers. The entrepreneur is the hub in the wheel of the economy's many interrelationships.
- **Create Market Equilibrium.** Entrepreneurs may be thought of as the agents which move markets toward equilibrium. When an industry is not in equilibrium, high profit opportunities exist which attract attention from observant businesspeople. If, for example, the price of a commodity was higher in one city than another, an entrepreneur would arbitrage by shipping the commodity between places to close the price gap. As described by Israel Kirzner and others, entrepreneurs are alert to such opportunities and take action to close such imbalances that they discover.<sup>121</sup>
- **Create Market Disequilibrium.** A somewhat different role was envisaged by Joseph Schumpeter who saw the entrepreneur as initiating revolutionary changes which moved the economy away from the current equilibrium.<sup>122</sup> The entrepreneur provokes "creative destruction" by introducing new products, new management techniques, or new production processes to the economy. This disturbs economic stability, and moves the economy in a new direction. In this view, disruptive innovation is the entrepreneur's main role.<sup>123</sup>
- **Bear Uncertainty.** Many economists, building on the insights of Richard Cantillon, Frank Knight, and others, have stressed the entrepreneur's role in bearing uncertainty.<sup>124</sup> As this paper has noted, the modern economy is replete with technological and market uncertainties. While market institutions, such as insurance, take care of normal quantifiable risks, entrepreneurs must grapple with unquantifiable types of risks, such as introducing new products to markets. If successful, high profits are the reward that entrepreneurs earn for such beneficial activities that few people wish to undertake.<sup>125</sup>
- **Act on Unique Knowledge.** The entrepreneur's role can be understood by realizing that individuals have a very limited range of knowledge compared to the vast totality of information in the economy. As F.A. Hayek stressed, information is dispersed widely so that each individual or business has a unique knowledge base gained from their own particular situation and experience. Entrepreneurs are those that act on such specialized knowledge, and earn a profit if it proves to be valuable. For example, an engineer who observes a new technique being used in one industry may adapt it for use in another. By doing so, she produces new information, causes market prices to re-adjust, and generates economic growth by creating something new and better.

Today, greater attention is being paid to the role of entrepreneurs because of the increasing focus on dynamism in the economy, in contrast to the static orientation of traditional

economic theory. The new focus on dynamism is not surprising given the fast pace of change caused by the computer revolution, globalization, and other factors. Today's economy has been likened to an ecosystem which continually changes and evolves. A 1998 Small Business Administration report noted, "The U.S. economy is a dynamic organic entity."<sup>126</sup> This view has its roots in thinking by economists in the Austrian school and others outside the mainstream.<sup>127</sup> For example, Joseph Schumpeter noted, "The essential point to grasp is that in dealing with capitalism we are dealing with an evolutionary process."<sup>128</sup>

Mainstream economic theory likens the economy to a mechanical device, which could seemingly be controlled and fine-tuned by a central authority to achieve optimal efficiency. Labor and capital are assumed to be undifferentiated inputs to production like gas in a car engine. By contrast, in the evolutionary view, growth comes from individual action, diversity, and experimentation. Successful experiments are copied and adopted widely to generate economic growth. Entrepreneurial actions are at center of this evolutionary understanding of the economy.

The basic conception or model that is used to understand the workings of the economy is very important because public policy flows directly from this understanding. As Albert Einstein said, "Our theories determine what we measure."<sup>129</sup> As noted, placing too much weight on mainstream theory overemphasizes purported market failures, and ignores entrepreneurial solutions. Professor Nelson has discussed why false theories can result in policymakers overreaching their abilities:

In real capitalist economies, in contrast with the neoclassical models, technological advance proceeds through an evolutionary process, with new products and processes competing with one another in real time, rather than solely in ex-ante calculation. Some of the innovations will be winners, other losers. With the vision of hindsight the whole process looks messy and wasteful, and a more coherent planning approach to technological advance appears attractive.<sup>130</sup>

Unfortunately, many policymakers have mistakenly believed that a "more coherent planning approach" to the economy can actually work. But as Section III illustrated, uncertainty is pervasive in the modern economy, and a centralized strategy to create growth is not feasible. Growth must be left to the entrepreneurs. Professors Nathan Rosenberg and L.E. Birdzell find, "The failures of planning can be attributed in part to its conception of an economic system as a lifeless machine, without the internal capacity to change, adapt, grow, renew, reproduce itself, and shape its own future."<sup>131</sup> Entrepreneurs breathe life into the machine and create change, renewal, and growth, as described in detail in the following sections.

## **B. How Entrepreneurs Create Economic Growth**

### **1. Radical Innovators**

Every industry experiences occasional upheavals caused by new technologies, new business models, and other innovations.<sup>132</sup> The Internet explosion and the development of just-in-time manufacturing methods are examples of such changes.<sup>133</sup> These types of “disruptive” or “radical” innovations are usually unexpected, and greatly disturb existing producers and market relationships.

Economic studies have found that new entrepreneurial firms have been the source of most disruptive innovations in the economy.<sup>134</sup> A well-known example is the pioneering of personal computers by upstart Apple, which Professors Rosenberg and Birdzell note, “was not undertaken by any of the leading American computer manufacturers, nor by the Soviet Union, nor by the French Commissariat du Plan, nor by MITI in Japan.”<sup>135</sup> More recently, the pioneering of Internet retailing was undertaken by companies such as Amazon, and not by established bricks and mortar retailers.

By contrast, large, established companies are the main source of incremental or “sustaining” innovations, which improve technology and production efficiency in a more orderly manner. Intel's success at improving the speed and performance of microprocessors over three decades is a good example of sustaining innovation. Such improvements aim at steady improvement of known processes or products, and are certainly vital to economic growth. The huge R&D budgets of large technology companies typically aim at such sustaining innovations.

But established firms often overlook more radical innovations, as suggested by a long list of new products that were championed by new businesses. Professor Clayton Christensen examined this phenomena in his award-winning 1997 book, *The Innovator's Dilemma*.<sup>136</sup> Professor Christensen’s study of the computer hard drive industry traces six major disruptions from the 1970s to the 1990s based on new size standards (14-inch, 8-inch, 5.25-inch, 3.5-inch, 2.5-inch, and 1.8 inch drives). During this period, the industry was highly dynamic with over 100 firms entering and exiting. Each new disk drive size standard was generally overlooked by dominant firms and pioneered by new firms. Established firms created sustaining innovations within each size standard, but underestimated the potential of new disk sizes when they arose.

Professor Christensen does not attribute the success of upstart companies to simply bad management on the part of large, established firms. Rather, large companies have subtle but powerful biases that result in their overlooking new opportunities. First, big new markets typically don't start out big; instead, they usually start out as small niches and tend to be ignored. Second, corporate managers are trained to stay close to existing customers and fill their needs, rather than pursuing markets that currently don't exist. Third, managers in stable, established companies favor familiar investments with seemingly predictable returns. New niche markets seem to promise lower and more uncertain returns.

In addition, big firms often harbor opposition to radical new ideas. After all, investments in new areas often mean shifting resources away from managers with existing customers. A

1999 *Harvard Business Review* article called large corporations “the last bastion of Soviet-style central planning” because new investment ideas often must go through numerous bureaucratic decision layers.<sup>137</sup> Unconventional ideas are out of luck in such a system. By contrast, the article noted that in entrepreneurial Silicon Valley, “there’s no one person who can say no to a new idea. Power is diffuse, and there are many sources of capital.”

In his book on American entrepreneurial history, Professor Larry Schweikart draws similar conclusions to Professor Christensen.<sup>138</sup> He notes that, “the established leader in an area is usually unlikely to pioneer the next major breakthrough.” At the time of Alexander Graham Bell's invention of the telephone in 1876, Western Union dominated the telegraph market, and was in the best possible position to develop the telephone. But Western Union didn’t invent the telephone, nor did it initially realize its potential. Western Union's president described the new device as a “toy” and initially rejected Bell's offer to sell him the patent rights.<sup>139</sup> Similar stories of the triumph of newcomers emerge in industries as diverse as the ocean-going ships, transistor radios, and heavy construction equipment.<sup>140</sup>

The core of the problem for established firms is that radical innovations are essentially unplannable.<sup>141</sup> Unplannable opportunities are missed by large firms because they usually focus on big predictable markets with quantifiable payoffs. By contrast, start-ups generally don’t pay much heed to sophisticated analyses of market projections and payoffs.<sup>142</sup> In addition, small entrepreneurial firms simply have numbers on their side because many small firms pursue a multitude of paths, but the small number of big firms in an industry pursue just a few.

How important are “radical” innovations to the economy? Studies have found that about half of technology progress stems from new radical innovations, with the other half stemming from incremental or sustaining improvements.<sup>143</sup> The importance of new entrepreneurial companies is clear when one considers that perhaps 95 percent of radical innovations come from new companies, and not big, established firms.<sup>144</sup>

A classic story of a new firm rising to greatness on the basis of a radical innovation is Xerox Corporation.<sup>145</sup> Before Xerox introduced the first modern photocopier in 1960, businesses used messy and inefficient mimeograph machines to copy documents. In 1947, a small manufacturer of photographic papers, Haloid Corporation, found an independent tinkerer, Chester Carlson, who had through trial and error developed a process using chemicals and static electricity to reproduce images. Carlson had tried to convince leading companies, including IBM, Kodak, and 20 others, to back his invention, but was turned down by all of them before he was approached by Haloid. Haloid saw something in the crude process that the big business equipment companies at the time apparently didn't.

Carlson reached agreement with Haloid in 1946 and the team spent 14 years struggling to refine the process and register patents on their discoveries. With minimal earnings and only a distant and unsure promise of success, Haloid pumped \$75 million of borrowed money and proceeds from share issues into research. This was “venture capital” long before today's organized venture capital markets. Visionary leadership by Haloid's Joseph Wilson kept morale high, and he persuaded enough financial backers that this unproven technology would be the wave of the future.

After many failures and premature predictions of success, Haloid introduced its landmark model 914 in 1960. Haloid changed its name to Xerox in 1961 and would soon grow into a giant. Xerox realized that the machine's high price tag would be a barrier for many customers so it developed an innovative leasing program to make the machine more affordable. The machine was a huge success and sales quickly soared into the hundreds of millions of dollars. Xerox's long years of experimentation and perseverance had led to the creation of not just a new product, but a whole new industry.

The triumph of Xerox and their radical innovation illustrates how crucial new entrepreneurial businesses are to the economy. The economy can't rest on the economic laurels of its current industry leaders because today's new businesses will be the Fortune 500 businesses of tomorrow.

## **2. Growing Small Niches into Big Industries**

Some of the biggest technology firms today, including Intel and Microsoft, started out in niche markets with specialized products.<sup>146</sup> Niche markets are like small fault lines of which some will develop into major earthquakes. But nobody knows for sure which fault line will become the next earthquake, so independent entrepreneurs have a good chance at beating the largest corporations if they take advantage of the niche opportunities available to them.

Bill Gates began his career by writing computer code for an obscure hobbyist computer called the MITS Altair in the mid-1970s. This would not have seemed like the path to the top of the computer industry at the time - it was a niche market (software) within a niche market (home computers). Instead, the mini and mainframe computer industries would have appeared to be the path to a successful technology career. Mainframe and minicomputer companies overlooked the microcomputer niche that outsiders like Gates were starting to explore.

Intel's central role in the remarkable growth of the microprocessor industry makes one forget that they also started out as a niche firm. Founded in 1968, Intel created the first dynamic random access memory, or DRAM, semiconductors. Before then, computer memory had been supplied by firms making magnetic core storage. One account of the industry noted, "Others in the industry predicted that they [DRAMs] would cost about ten times as much as magnetic cores. As a result, few firms saw any commercial possibilities in developing them."<sup>147</sup> But Intel did, and DRAMs quickly became the dominant storage medium. Intel then moved on to creating the world's first microprocessor, which put an entire central processing unit on a single chip. This chip, the 4004 introduced in 1971, followed by the 8080 in 1974, heralded the beginning of the modern computer age. But surprisingly, there was again initial commercial uncertainty regarding these new devices because it wasn't clear where the market for them would be.<sup>148</sup>

Big firms often ignore small niche markets because they don't appear at first to be important enough to warrant attention. Professor Christensen notes that niches don't appear to solve the growth needs of big corporations because they aren't "large enough to be interesting."<sup>149</sup> Large corporations with aggressive growth goals instead tend to aim at markets

that they believe will become very large. By contrast, small companies are more eager to explore small, experimental opportunities - only later does it become clear that some of these small opportunities mushroomed into big ones.

Another well-known story of an entrepreneurial company that grew an ignored niche into a huge market is Nucor's pioneering of the minimill steel industry.<sup>150</sup> Minimills make steel from scrap metal in electric arc furnaces, and they can reach high efficiencies with smaller output levels than the large integrated steel makers. Minimills have grown from nonexistence in the 1960s to over 40 percent of the steel market by the 1990s.<sup>151</sup> These gains have been won by new firms such as Nucor, rather than the formerly dominant integrated producers who had higher cost structures. While the integrated steel makers have made great strides in efficiency in recent decades, they tended to ignore the potential of minimills because they initially produced lower quality products. But since Nucor's first minimill in 1969, minimills continuously improved their quality and expanded into up-market steel products to win business from the integrated firms. Nucor also jumped on the new thin-slab casting process in the late 1980s before the integrated firms who were more risk-averse.

The big role that small firms play in the economy is experimentation on the uncertain fringes of markets. For example, every business has by now jumped on the Internet bandwagon, but the real entrepreneurs took the big risks a decade ago when the rewards were very uncertain. As far back as the early 1980s, Steve Case, co-founder of America Online, was exploring the consumer potential of home computers interacting over the phone lines. In a recent biography of Case, the *Washington Post* noted that he "jumped on a once-screwball belief – that computers would become tools for mass communications."<sup>152</sup> Case turned that screwball belief into gold. He grew small Quantum Computer Services in 1985 into today's AOL which serves 25 million homes. Case's AOL far outstripped what were then bigger competitor systems with deeper corporate pockets including CompuServe and Prodigy, the latter of which was backed by Sears Roebuck and IBM.

A recent study by PricewaterhouseCoopers (PwC) found that big companies can be overly cautious in exploration of untested markets.<sup>153</sup> Their survey of senior executives of 800 large corporations found that most only go ahead with a new product if there is an estimated 80 percent chance of success. PwC believes that this is too high a threshold and companies get "analysis paralysis" in trying to predict unpredictable market outcomes. Professor Amar Bhide also describes some reasons why big companies overlook niches:

Large corporations tend to pursue initiatives with large initial investment requirements and low uncertainty...stringent evaluation and monitoring requirements encourage them to pursue a few large projects rather than many small ones. Multilevel evaluations of new initiatives also limit the uncertainty that corporations can tolerate.<sup>154</sup>

Once smaller, entrepreneurial firms are up and running in niche markets, their flexibility and adaptability gives them an edge over large competitors.<sup>155</sup> For example, a Merrill Lynch analyst recently noted regarding Yahoo's success, "Disney and others have tried very hard and

put an extraordinary amount of effort into trying to create Internet properties as dominant as Yahoo and haven't been able to do it."<sup>156</sup> Once in a niche, further opportunities to grow will be quickly acted upon by the footloose entrepreneur. For large firms, corporate checks and balances usually require extensive planning for any changes in direction. So the value of corporate planning is reduced in volatile industries, such as high-tech, giving the leg up to smaller firms.<sup>157</sup> Professor Bhidé believes that this vulnerability is the "inevitable consequence of the separation of ownership and management" in big corporations.<sup>158</sup>

Large corporations are increasingly recognizing their vulnerabilities. *The Economist* notes that the terror of small-firm innovation is one of the main drivers of today's acquisition boom.<sup>159</sup> For example, since 1993, Cisco has bought 51 companies for a total of \$15 billion.<sup>160</sup> Another response of big technology companies has been to set up their own venture capital funds. Intel, for example, has pumped \$2 billion into venture investments in the past decade.<sup>161</sup>

In summary, the roles of small and large, and new and established firms in the economy are complementary. Large firms can do many things better than small firms, such as investing huge amounts in R&D to create "sustaining" innovations. Smaller entrepreneurial companies are better suited to exploring the potential of niche markets to uncover the next radical innovation that will reshape the economy.

### **3. Generating Competition**

Whenever an industry provides poor service, charges high prices, or is falling behind the times, an entrepreneur will see an opportunity to profit. New business formation by entrepreneurs provides a fundamental competitive check in a market economy. Professors Rosenberg and Birdzell note, "The easy formation of new enterprises also acts as a disciplinary device for older enterprises. The same human forces that produce bureaucratic rigidities in mature government agencies are also at work in mature economic enterprises, in both cases, opposing the forces that produce change and growth."<sup>162</sup>

An outstanding example is MCI's fight to introduce competition to long-distance telephone markets. By the 1960s, AT&T's long distance monopoly had lasted for half a century under a regulated industry structure. Prices were high, and the industry was slow to innovate. MCI's ultimate success forced prices down and spearheaded the roll-out of fiber optic technology that AT&T had been slow to adopt.<sup>163</sup>

In the late 1960s, a two-way radio salesman named John Goeken thought that microwave technology could be used to offer an alternative to AT&T's business-to-business long distance. To break into AT&T's markets, Goeken realized he would need both a great deal of financial support and experts to help him fight for Federal Communications Commission (FCC) approvals. After a lengthy search, he convinced William McGowan, a self-made millionaire, to support his cause. MCI began a decade-long struggle to enter AT&T's long distance markets. The FCC allowed MCI partial entry in 1969, but McGowan kept pushing and launched an antitrust suit against AT&T in 1974. The federal government followed McGowan's lead and filed an antitrust suit later the same year. The two suits were eventually wound up in the early

1980s with the break-up of AT&T, and two decades of rapid innovative and price reductions in telecommunications have followed.

MCI needed what all entrepreneurs with big ideas need - plenty of far-sighted investors willing to take risks. The risks were great in MCI's case because of the regulatory uncertainty and seeming invincibility of Ma Bell. MCI racked up losses of \$76 million through the mid-70s, and at times its stock price plummeted to a fraction of its prior value. Venture capitalists plowed \$100 million into MCI, the company raised another \$30 million from a 1972 IPO, and tens of millions of dollars were raised from bank loans and private investors. In the early 1980s, \$2 billion was raised from a high-yield bond issue to complete a major expansion.<sup>164</sup> As described in Section II, diverse sources of risk-capital are one of American entrepreneurs' best competitive assets.

Among the consequences of MCI's fight, and U.S. telecom deregulation generally, has been the explosion of the Internet. Thousands of entrepreneurs have jumped on the new opportunities opened up by the Internet to tackle inefficiencies in every industry, often by getting rid of the "middlemen" in markets. Transaction costs are being reduced, price comparisons are easier, and barriers to entry are falling, thus prompting some to call the new economy the "nude economy."<sup>165</sup> For example, Michael Dell's Dell Computer bypassed computer distributors to cut costs to consumers. By offering customers a better deal, Dell has grown his company to become the largest computer maker in the United States.

The rise of Internet retailing illustrates a general feature of entrepreneurial economies: the greatest business fortunes are made by serving the needs of the mass market. Most great entrepreneurs have not become rich by serving the rich, but by lowering prices on products for all consumers.<sup>166</sup> Henry Ford's Model T was designed as a "car for the great multitudes."<sup>167</sup> Ford's simplicity of design, improved parts casting, and moving assembly line allowed him to lower the price of the Model T from \$825 in 1908, to \$575 in 1912, and finally to \$290 in 1927 its last year of production.<sup>168</sup> Entrepreneur Joseph Bulova turned a similar trick by bringing standardization of parts and mass production to the U.S. watch and clock industry in the 1920s, allowing millions to buy quality time pieces for the first time.<sup>169</sup> Entrepreneurs in many other industries such as firearms, sewing machines, and bicycles also adopted the new ideas of standardization and mass production so that every family could afford these products. Many of the biggest retail empires, including K-mart, Target, Costco, and Wal-Mart, have grown by initially serving budget market needs and then undercutting major retailers from below.<sup>170</sup>

In addition, consider Andrew Carnegie's achievements. In the late 1860s, he saw the newly invented Bessemer steel process on a trip to England and realized its potential. Upon return, he implemented the process in America and dramatically reduced the cost of steel production.<sup>171</sup> Lower steel costs created wide-ranging ripple effects on the economy, such as pushing down rail transportation charges. By the 1890s, the cost of rails was just one-tenth their cost two decades earlier.<sup>172</sup> These innovations opened up cross-country travel to millions, and pushed down rail freight rates 40 percent in twenty years.<sup>173</sup> Historian Paul Johnson noted that Carnegie exemplified 19th century U.S. entrepreneurs who, "By achieving enormous economies of scale, turned the luxuries of the rich into the necessities of the poor, and thereby reduced the real price of almost everything."<sup>174</sup>

British entrepreneur Richard Branson is a contemporary example of the restless quest to give consumers more for less. Branson began his career at age 16 with a string of unprofitable start-ups in the 1960s and early 1970s, before he struck it big with Virgin Records and Virgin Atlantic airlines.<sup>175</sup> From there he has made forays into nightclubs, software, cola, mortgages, mobile phones, and many other businesses.<sup>176</sup> The Virgin Group today is a “business-making machine” with about 200 firms in widely varying industries and \$5 billion in revenues.<sup>177</sup> Branson thinks of himself as a consumers’ champion who is always on the lookout to bring style, quality, and better value to new markets. Some of his ventures succeed and some fail, but the economy gains from both. Branson notes, “Hopefully we learn from our mistakes ... if something completely fails, as long as we pay off all our debts and nobody gets hurt, then I don't think people disrespect Virgin for trying.”<sup>178</sup>

#### **4. Acting as the Economy's Guinea Pigs**

This report has stressed the large uncertainties inherent at the leading edge of modern technological economies. As discussed, no one is an expert on foreseeing future economic events, including even the brightest entrepreneurs. Instead, what makes entrepreneurs unique is that they act in the face of this uncertainty. Entrepreneur Margaret Rudkin, founder of the Pepperidge Farm food company, used to say in speeches, “The IBM company used that wonderful one-word slogan, ‘Think.’ But I believe we should add another word to it, and that word is ‘Try.’ There is not much point thinking if you don't carry out your ideas.”<sup>179</sup>

Economist John Maynard Keynes recognized that big uncertainties faced many industries, and he realized that innovations wouldn't happen if businesspeople simply made easy-to-quantify decisions. Instead, a certain boldness or “animal spirits” must drive entrepreneurs forward to try new things and risk failure.<sup>180</sup> Even today's experts in risk, the venture capitalists, usually rely on hunches and not number-crunching to figure out which start-ups to invest in.<sup>181</sup> Such hunches or animal spirits are ultimately based on a spirit of hope and optimism that an experiment will succeed.

Consider the gutsy story of San Diego's Qualcomm Inc., a leader in wireless telecommunications. The firm was founded in 1985 by former MIT professor, Irwin Jacobs, who developed the idea for a superior high-speed mobile phone technology. Despite huge unknowns when he started, Jacobs pursued his ideas and made them work. Qualcomm today holds key patents to the CDMA wireless standard that it created. But as the *Washington Post* noted, “In the mid-1990s, CDMA was viewed as so risky that manufacturers of its first systems ... refused to issue guarantees that the networks would work.”<sup>182</sup> Similarly, a Goldman Sachs analyst noted regarding the company’s early years, “To claim that a handful of engineers could actually do this was preposterous,” and *Business Week* noted that the establishment initially “laughed” at Qualcomm's bold plan.<sup>183</sup> Nonetheless, Qualcomm stuck to its guns and solved the key technology barriers. Today, the company has annual revenues of \$4 billion, and 15 percent of the world’s cell phones use their technology.

The only way to find out whether new ideas will work is if someone takes the risks to find out. Consider Maryland biotechnology firm Celera Genomics. Celera’s founder, Dr. Craig

Venter, stunned the scientific world in 1998 by announcing that he would privately take on the task of sequencing the human genome.<sup>184</sup> He said he would complete the task at one-tenth the cost and five years before the publicly-funded Human Genome Project was scheduled to be completed.<sup>185</sup> Back then, many leading scientists thought his approach would likely fail, and they claimed that it would be riddled with errors if he actually did complete it.<sup>186</sup>

In June 2000, Celera finished sequencing the human genome, and joined forces with the publicly-funded project as they neared completion. Skepticism about Dr. Venter's strategy is now gone, and most scientists think that private competition was very beneficial to the government project. Dr. Venter has said that he proved that his "shotgun strategy could work on complex genomes." In fact, the government-funded effort has now adopted his once-derided technique to sequence a mouse genome. Dr. Venter noted, "They realize that [our] strategy is faster, cheaper, and of equal or greater quality, than the conventional approach."<sup>187</sup>

The success of Qualcomm and Celera illustrate how the entrepreneurial economy is a learning machine. The economy learns from failures as well as successes. Apple Computer's Newton of the early 1990s was the first hand-held computer. The Newton was generally regarded as a technical success, but it failed in the market. But who can blame Apple – the market for hand-helds didn't exist before they tried to invent it. Their efforts provided the lessons for later entrants and paved the way for the Palm Pilot revolution of the 1990s.<sup>188</sup> As Professor Christensen notes, "Markets that do not exist cannot be analyzed: suppliers and customers must discover them together."<sup>189</sup>

Entrepreneurs themselves "learn by doing" in an iterative process. Entrepreneurs frequently adapt their initial business strategies in light of their many stumbles and unforeseen opportunities.<sup>190</sup> They often encounter problems or opportunities that were invisible before they began.<sup>191</sup> As Professor Christensen notes, "Action must be taken before careful plans are made."<sup>192</sup> For example, Jeff Bezos, founder of Amazon.com, initially did not plan to stock inventory, but instead to order books from suppliers after customer orders were already received. Once in business, Bezos found out that that process was too slow, so he invested heavily in warehouses to provide faster service.<sup>193</sup> An industry insider said of Bezos, "He's inaugurated a business model of "Ready, Fire, Steer," not "Ready, Aim, Fire."<sup>194</sup>

Similarly, consider the early automobile industry. At the end of the 19th century, there was great uncertainty as to whether steam, electricity, or gasoline would be the best fuel source for horseless carriages.<sup>195</sup> Many technical and marketing experiments were needed to discover that gasoline was the best way to go. Ransom Olds, the father of the U.S. automobile industry, was faced with many failures before he eventually succeeded. Years of work on steam-powered cars resulted in major failures in 1887 and 1892. He finally succeeded with a gasoline-powered model in 1896, and established the first successful gasoline-powered car company in the country in 1899.<sup>196</sup> Even so, this didn't convince everyone: Thomas Edison asserted in 1910, "The nickel-iron battery will put the gasoline buggy .. out of existence in no time."<sup>197</sup>

The rise of Fred Smith's Federal Express provides another story of entrepreneurial market discovery. While we take overnight express delivery for granted now, it was up to Fed Ex in the 1970s to show that there was enough demand to warrant it. Smith acted in the face of

substantial market and regulatory uncertainty.<sup>198</sup> He first conceived of the idea for a high-priority small package delivery service in a college paper in mid-1960s, although he ironically received a poor grade on the essay. After serving in Vietnam, the inexperienced 26 year-old launched his company in 1971, and struggled to build from the ground up the infrastructure to deliver packages overnight across the country.

Smith began his entrepreneurial climb by purchasing and growing a small Arkansas aviation sales company. Smith thought big: unlike other shippers, he wanted a dedicated fleet of at least two dozen jets and a central hub operation to create the efficient delivery service he envisioned. He would need a lot of upfront capital, and he set about raising \$50 million from family funds, bank loans, venture capital, private investments, and an IPO. Federal Express began operations in 1973 delivering just 186 packages on its first day of operations. In the early years, the company struggled to assemble a fleet, dodge bankruptcy, delay creditors, raise fresh funds, and secure customers. Fed Ex finally turned an annual profit in 1976 and became a billion dollar company by the early 1980s.

Smith had also to struggle with the federal government in order to grow his business. Smith needed special permission from the Civil Aeronautics Board (CAB) to begin air operations because air routes and schedules were heavily regulated at the time. Fed Ex won the approval they required in 1972 despite lobbying efforts by other interests to hold back this new competitive threat. Federal regulators almost dealt Fed Ex other knock-out blows in its first few years. In 1973, federal fuel rationing rules threatened to limit availability of fuel to Fed Ex's fleet, but they luckily received a special dispensation. In 1976, Fed Ex had to beg the CAB to allow it to purchase larger jets for expansion. This time Smith's competitors got the upper hand in lobbying, and the CAB denied Fed Ex's request. But the mood in the country was moving towards deregulation, and Fed Ex received a boost with the 1977 act of Congress which deregulated air cargo routes and prices, and allowed Smith to acquire larger planes.

Smith's story highlights a number of interesting policy issues. Like MCI, much of Fed Ex's entrepreneurial struggle regarded attaining the legal right to operate in the most efficient manner to best serve consumers. Both companies faced regulatory barriers which drove up costs, drained entrepreneurial energies, and made it more difficult to attract investors because of the added uncertainty. For Fed Ex, uncertainty regarding CAB's rulings impacted their ability to raise money because political risk reduced the certainty of investor returns.<sup>199</sup>

In an earlier decade, Fed Ex and MCI may not have been successful. But the move towards deregulation in the 1970s and 1980s in transportation and telecommunications paved the way for both companies. Entrepreneurs like Fred Smith and Bill McGowan pushed this process along. In addition, deregulation and innovations in the financial markets during these decades gave entrepreneurs greater access to the risk capital necessary to grow their businesses.<sup>200</sup>

As the economy's guinea pigs, entrepreneurs generate new knowledge of technologies, production costs, consumer preferences, and other unknowns. Their reward for bold action in the face of uncertainty is a high financial return if they are successful. As Michael Lewis notes of Netscape founder and serial entrepreneur, Jim Clark, "Clark's willingness to take risks others shunned was the source of his financial power."<sup>201</sup>

## 5. Turning Inventions into Innovations

Europe and America's historical rise to prosperity is sometimes portrayed as the result of a steady process of simply accumulating new machines and inventions. In this view, scientific advances are seen to almost automatically create higher living standards. This understanding of economic history can be called the "science push" theory of growth. While this story contains some truth, it is akin to considering the action on only one side of a pair of scissors.<sup>202</sup>

The other side of the scissors is the "demand pull" of markets. Demand drives growth by pulling discoveries towards areas where there are growing markets. Entrepreneurs are the link between the push side of inventions and the pull side of demand. They bring about innovation by connecting inventions to markets in a trial-and-error process.<sup>203</sup> This role may be as important as invention itself. For example, empirical evidence has found that, "The rate of technical change and of economic growth depends more on efficient diffusion than on being first in the world with radical innovations."<sup>204</sup>

Economic growth in some societies that had abundant inventions was stunted because entrepreneurs did not have the freedom to spread innovations to average citizens. Harvard Professor David Landes provides some illustrations in his recent book.<sup>205</sup> He finds that a number of non-Western civilizations produced many inventions sometimes hundreds of years ahead of Europe. Islamic science, for example, is thought to have been more advanced than Europe's from about 750 to 1100 A.D.<sup>206</sup> And the Chinese have a long list of inventions to claim, including paper, printing, gunpowder, the compass, and the stirrup.

However, the Chinese economy suffered under an extensive government bureaucracy during many centuries.<sup>207</sup> The government strictly regulated a wide range of social and economic activity. Entrepreneurs were not free to convey inventions to the people if it wasn't in the interests of the centralized bureaucracy, unlike in Europe where authority was more fragmented. For example, in Europe the invention of the mechanical clock in the late 1200s created large changes to society as it spread rapidly across the continent. A ready market encouraged craftsmen throughout Europe to refine and improve this mechanical wonder to lower costs and improve accuracy. For example, the invention of the pendulum clock mechanism in the late 1650s by the Dutchman Christiaan Huygens almost immediately generated a proliferation of new entrepreneurial companies in England to market the breakthrough to average English families.<sup>208</sup> Very soon English entrepreneurs were also competing to improve on the mechanism's design.

In contrast to Europe, Professor Landes notes, "The Chinese treated time and knowledge of time as a confidential aspect of sovereignty, not to be shared with the people."<sup>209</sup> As a result, he concludes, "Without a basis in popular consumption, without a clock trade, Chinese horology regressed and stagnated."<sup>210</sup> Professor Landes notes that other advancements that spurred growth in the West, such as new spinning machines, coal smelting and iron technologies, and shipping, actually lost ground in China when the government decided that they weren't high priorities.

The Chinese inventions of paper and printing did not generate the great diffusion of knowledge that they did in Europe. The Chinese authorities were not keen on new ideas or dissent. By contrast, in Europe printing exploded, particularly after Gutenberg's invention of movable type in the 15th century, because governments could not control it. Within 45 years of Gutenberg, nine million books had been printed in Europe.<sup>211</sup> In Europe, innovation fueled further innovation: it was Huygens detailed description of his new pendulum mechanism in his 1658 book that allowed entrepreneurs to almost immediately start manufacturing and marketing the invention hundreds of miles away in London.<sup>212</sup>

Professor Landes concludes that in Europe, "Innovation worked and paid, and rulers and vested interests were limited in their ability to prevent or discourage innovation. Success bred imitation and emulation."<sup>213</sup> Economic historian Angus Maddison agrees that the Chinese "showed precocity in major inventions," but that the powerful bureaucracy, supported by tradition and the education system, promoted orthodox thinking.<sup>214</sup> As a result, potential Chinese entrepreneurs could not turn inventions into beneficial products for average people and the bulk of the population stayed poor. Another historian concluded that:

The ingenuity and inventiveness of the Chinese ... would no doubt have enriched China further and probably brought it to the threshold of modern industry, had it not been for this stifling state control ... It is the State that kill[ed] technological progress in China.<sup>215</sup>

Meanwhile in Europe, entrepreneurs were gaining the upper hand over authority and vested interest with the rise of the Industrial Revolution in the 18th and 19th centuries. This period would not have been a "revolution" if it consisted only of a sequence of famous inventions without entrepreneurs struggling for their implementation. Even Marx and Engels attributed the explosive growth in the Industrial Revolution to the capitalist entrepreneurs who financed the investments and broke down societal barriers to create a growing demand for technological advances.<sup>216</sup>

The entrepreneurs of the Industrial Revolution fought not just market uncertainties, but government regulations and trade restrictions, monopoly guilds, superstitions, ancient prejudices, and entrenched institutions. The infamous English Luddites who rioted for the destruction of new textile machinery during 1811-1816 were one of many barriers that entrepreneurs faced in lifting the living standards of the masses. In this particular case, the advances in clothing manufacturing made possible by the new machines, such as the cotton gin, greatly improved living standards and cut disease rates as durable and washable fabrics, particularly cotton, became widely available and costs fell dramatically.<sup>217</sup> Contrary to the Luddites' view, the textile entrepreneurs of the 19th century were great benefactors of every citizen.

Certainly, economic growth can be a painful process. But the more hospitable is the environment for entrepreneurs as the agents-of-change, the faster that inventions can be turned into higher living standards for all.<sup>218</sup> The more hospitable environment for change created by the Renaissance and the Enlightenment allowed Europe to pull ahead of the rest of the world from about 1500 onwards.<sup>219</sup> Professors Rosenberg and Birdzell note that the breakdown and

diffusion of European power starting about this time led to “an attack of human hyperactivity – scientific, literary, musical, dramatic, military, political, and commercial.”<sup>220</sup> This hyperactivity ensured that diverse new approaches were tried in every area of human endeavor.

By the 1800s, living standards were rising dramatically in the West – this was the age of the great railroad, telegraph, and steel entrepreneurs. Between 1820 and 1900, for example, GDP per capita more than tripled in the United States. By contrast, China’s per capita GDP rose just 25 percent during this period.<sup>221</sup>

One of the great entrepreneurs of the Industrial Revolution in the United States was Samuel Morse. Morse exemplified the process of turning invention into innovation with his championing of the telegraph. The telegraph perhaps changed society in the 19th century more than any other invention, but the industry had many fits and starts before it finally exploded in the mid-1840s. Morse was a tinkerer who borrowed some inventions and added his own, including Morse Code. Perhaps more important than his inventions was his persistent support for the idea of long-distance communication over wire. Like other promoters of new technologies, he encountered great amounts of skepticism. The *New York Times* obituary of Morse noted, “the invention seemed altogether too chimerical to be likely ever to prove of any worth. Again and again he was pronounced a visionary, and his scheme stigmatized as ridiculous.”<sup>222</sup> But Morse persisted and proved the critics wrong.

After the telegraph began spreading on either side of the Atlantic, Morse and others pursued the possibility of joining the continents with a cable in the 1850s and 1860s. Substantial amounts of risk capital would have to be raised, but this was difficult because “nobody who knew anything about telegraphy would be foolish enough to risk building a transatlantic telegraph; besides it would cost a fortune.”<sup>223</sup> Many failed attempts were made and investors were sought to pony up for each new effort. Each time a little more was learned, and the continents were finally linked permanently in 1866.<sup>224</sup>

When entrepreneurs introduce a successful innovation, they create a powerful stimulus to new R&D. After Morse showed that the telegraph would work, he created demand pull feedbacks that stimulated further research into electricity and communications. Inventors like Alexander Graham Bell and Thomas Edison were drawn to telegraphy research. They knew that they would have a ready place to sell inventions and earn high returns. Edison’s telegraphy profits helped to allow him to found Menlo Park where “inventions were goals chosen with a careful eye to their marketability.”<sup>225</sup> Bell was working on telegraphy equipment when he achieved the first voice transmission over wire, and a new technology explosion was underway.

## V. WHAT WILL ENTREPRENEURS DO NEXT?

### A. Entrepreneurial Waves

The wave of entrepreneurial activity that spurred the growth of the Internet has had many precedents, including the early growth of telegraphs, automobiles, canals, railroads, electricity, and radio.<sup>226</sup> Like prior technology revolutions, the Internet revolution is changing as it matures. Industries typically progress from waves of entrepreneurial start-ups to widespread consolidation. The 485 U.S. car companies at the start of the 20th century consolidated to just 44 by 1929.<sup>227</sup> The 300 aircraft manufacturers of the 1920s and 1930s consolidated to just a handful today.<sup>228</sup>

The Internet industry appears to be following the same pattern. “Even enthusiasts concede that as many as 80 percent of today's Internet companies may not survive – just as almost all the early railroads, car makers, and airlines did not,” notes *The Economist*.<sup>229</sup> A report by Forrester Research also predicts that most dot com retailers will fail and the industry will consolidate within a year.<sup>230</sup>

Small entrepreneurial companies typically lead in new industries which have high uncertainty. As new technologies mature, larger companies take the lead as economies of scale become more important.<sup>231</sup> Professor Nelson notes that small and new firms are important sources of new technology, but as a technology matures experience counts more and further improvements become more expensive, thus giving the edge to larger firms.<sup>232</sup>

The telegraph industry – the “Victorian Internet” – provides a good illustration. Years of experimentation with various technologies and “business models” characterized the industry up until the mid-1840s. Then, telegraph fever hit consumers, and financiers began to pour in money to expand the network. From a single line in 1845, the telegraph network mushroomed to 12,000 miles of lines operated by 20 companies just five years later.<sup>233</sup> Innovations caused the cost of messages to fall steadily until the 1870s when the industry matured and consolidated.<sup>234</sup> By aggressive expansions and acquisitions, Western Union accounted for 80 percent of the industry's volume by 1880.<sup>235</sup>

By this time, the original telegraph innovators were replaced by “the usual businessmen who take over whenever an industry becomes sufficiently stable, profitable, and predictable.”<sup>236</sup> Entrepreneurs and inventors now sought fortune elsewhere. Thomas Edison, who began his career by tinkering with telegraphy machines, moved on to his investigations into the phonograph, light bulb, and electric generator. Like many entrepreneurs, Edison used earnings from his early successes to give him the resources needed to invest in newer untried ideas. Alexander Graham Bell was also a telegraph equipment tinkerer. In 1876, he heard the first human voice transmitted electronically through his modified telegraph equipment.<sup>237</sup> His research sowed the seeds of the telegraph industry's eventual destruction. In just ten years a quarter of a million telephones were in use, and a whole new entrepreneurial wave had begun.<sup>238</sup>

The financial boom coincident with the rise of the Internet is following the pattern of prior technology waves, which also saw large flows of risk capital channeled to new firms. The 1920s stock market boom was fueled by growth in the automobile, radio, and electricity industries. While such market booms are sometimes regarded as wasteful “speculation,” in fact, they create enduring value to the economy, as documented by a new study of the 1920s boom.<sup>239</sup> This boom funded a large group of innovative new companies which later became enduring institutions in the U.S. economy, including RCA, Bristol-Myers Squibb, and Dupont. The study found that the relative number of patents issued during this period has only recently been topped. So while the 1920s boom ended in a crash, it also generated innovations and innovative companies that had greatly beneficial long-term economic effects.

It is possible that technology waves of the 21st century will differ from technology waves of the past. Perhaps large company size will become more important as the “network effects” of information-based industries lead to concentration.<sup>240</sup> But experts erroneously predicted in the 1970s that the age of high-tech start-ups was over and that Silicon Valley would consolidate.<sup>241</sup> Future industries may be less likely to become concentrated because of growing uncertainties in markets, and because smaller firms are benefiting from the trend towards collaborative R&D.<sup>242</sup> In a recent report, the OECD noted, “As new technologies and globalization reduce the importance of economies of scale in many activities, the potential contribution of smaller firms is enhanced.”<sup>243</sup> The report goes on to note, “Networking allows small and medium-size enterprises to combine the advantages of smaller scale and greater flexibility with economies of scale and scope in larger markets.”

Whatever the structure of future industries, we do know for sure that there will be many entrepreneurial waves in the 21st century. Future innovations may stem from advances in Internet technologies, biotechnology, nanotechnology, space travel, energy generation, and many other fields. The opportunities available to tomorrow’s entrepreneurs appear to be endless.

## **B. Creating Public Policy Change**

The momentum of change from today’s entrepreneurial and technological revolutions is making governments rethink their role in the economy. Many commentators have noticed the stark contrast between the rapid changes in high-tech industries, and the slow, ponderous actions of government. For example, while the federal Telecommunications Act of 1996 was generally regarded as a success, now only four years later many concede that it needs to be updated because of subsequent marketplace developments.

Entrepreneurs are a key force creating momentum to modernize federal economic policy. Consider the dynamic financial services industry. Last year’s repeal of the 67-year old Glass-Steagall banking laws simply reflected the vast changes in the financial services industry that had already been taking place for over two decades. Banks and brokerages had been creeping into each others businesses since the 1970s, and with recent large-scale bank/insurance/broker mergers the writing was on the wall for Glass-Steagall.<sup>244</sup> The Chairman of the House Banking Committee, Rep. James Leach, described how Congress followed the lead of entrepreneurs on this reform, “In terms of the law, the finance reform bill represents a profound shift. [But] in

terms of the marketplace, it's a moderate shift. The market always leads legislative changes. America is a very fast-changing society. Finance reform was needed in order to keep the law in step with market realities."<sup>245</sup> A similar situation is occurring with the rise of electronic stock trading networks and online stock trading, developments which are forcing federal regulators to re-assess nearly every stock market rule.<sup>246</sup>

American consumers are the ultimate beneficiaries when entrepreneurs help push reforms through government. Like Federal Express in the package delivery business and MCI in the telecommunications business, Enron has helped revolutionize the energy business by pushing for regulatory reforms and by fostering innovation. Like Fed Ex and MCI, Enron fought government regulations and entrenched market players in their efforts to give consumers better services at lower costs. Enron's Kenneth Lay has grown his company from \$5 billion to \$40 billion in revenues in a decade as he helped revolutionize the electricity and natural gas industries.<sup>247</sup>

Jim Clark is another entrepreneur who has had the boldness to tackle a big industry needing reform in the launching of Healthon (now WebMD). After founding Silicon Graphics and Netscape, Clark trained his sights on the health care industry after he figured that it spent billions of dollars each year on apparently wasteful paperwork flowing between doctors, patients, and insurers.<sup>248</sup> This presented a ripe opportunity for Clark who envisioned an efficient computer solution to the problem. He invested millions of dollars of his own money, and attracted millions more from venture capitalists, to launch a company in an industry he had no expertise in. Despite some ups and downs, Healthon/WebMD has linked up about half a million doctors, and it claims that its online systems can reduce the cost of health insurance claim transactions from about \$10 to under a dollar.<sup>249</sup>

The big question for governments is: Can bold entrepreneurs such as these cut costs and improve quality in inefficient and uninnovative public industries? Numerous industries within the government's domain appear to be ready targets for entrepreneurs, including postal services, public education, and space exploration.

- **Postal Services.** U.S. letter delivery is a legally-enforced monopoly under the federal "private express statutes." But postal delivery does have some entrepreneurial history in the United States. In the mid-19th century, Henry Wells, later the founder of Wells Fargo, and others entered competition with the federal Post Office. These private firms cut prices and brought substantial innovations to postal delivery, but they were eventually squeezed out by Post Office price cuts and legal actions.<sup>250</sup>

Today, U.S. Postal Service (USPS) annual revenues of over \$60 billion present a big target for entrepreneurs. The success of companies, such as Federal Express, in near-mail businesses raises the question of whether entrepreneurs should be allowed to compete again in regular mail delivery. There is movement in this direction. A member of the government Postal Rate Commission recently advocated privatizing the USPS and opening it to competition because "consumers would benefit from lower prices and better services."<sup>251</sup> Other countries, such as Sweden and New Zealand, have taken the lead and opened up their mail systems to competition.<sup>252</sup>

- **Public Education.** During the past decade, there has been a growing movement towards school choice in K-12 education, which is a huge \$300+ billion industry in the United States. Charter schools, school voucher programs, and new entrepreneurial school companies are creating alternatives to the traditional monopoly school systems in a growing number of states. Entrepreneurs are getting a chance to see if they can improve education under the flexible management offered by charter schools (public schools operated with greater autonomy) and new private schools funded with tuition vouchers. School entrepreneurs are not so much focusing on reducing costs, but rather on improving education quality and empowering parents.
- **Space Exploration.** NASA has dominated America's first 40 years in space, but private enterprise has played an important role in some areas such as communications satellites. There is a growing movement to open up all space activities to private enterprise. For example, a dozen start-up companies have raised hundreds of millions of dollars to build a space tourism industry.<sup>253</sup> According to an expert at NASA, these entrepreneurs are "adapting existing technologies and making them far cheaper to operate than the Shuttle."<sup>254</sup> NASA says it plans to offer use of the new space station to entrepreneurs who see commercial opportunities.<sup>255</sup> Another group of entrepreneurs plans to raise money through an IPO to lease the Russian Mir space station and operate it as a tourist destination.<sup>256</sup>

## VI. CONCLUSION

In recent decades, the high-tech revolution has coincided with an entrepreneurial revolution in the U.S. economy. New entrepreneurial companies have been the driving force behind the creation and harnessing of new technologies to bring innovation and growth to every sector of the economy. Economic growth has been strengthened as deregulation and financial market innovations have allowed entrepreneurs to raise large volumes of risk capital and launch their ideas into the marketplace.

The role of entrepreneurs can be perhaps distilled down to two key economic functions: they generate diverse market experiments and they create competition for established firms. As discussed, technological and market uncertainty are pervasive in the modern economy, particularly in leading-edge industries. As a result, government agencies or dominant companies cannot be relied upon to secure our economic future with overarching strategic plans. Instead, we can best tackle uncertainty and create economic growth by encouraging companies to pursue separate strategies, and by allowing them high levels of flexibility to respond to changing conditions.

In fact, the strength of diverse and decentralized economic decision making has been chronically underestimated, as gurus for over a century have falsely prophesized that capitalism will become monopolized by large cartels.<sup>257</sup> However, widespread and persistent challenges by new and aggressive entrepreneurial businesses have ensured that that has not happened in the United States. It seems even less likely to happen in the future because the economy continues changing rapidly and financial markets continue funneling large amounts of capital to independent risk-taking entrepreneurs.

As entrepreneurs explore every market niche and opportunity, they ensure that industries don't stagnate and fail their customers. Many formerly sluggish and monopolized industries have been opened up and transformed by entrepreneurs in recent decades. Building on this experience, policymakers should consider whether entrepreneurs could add value to industries still operated as monopolies, such as postal delivery and the public school system. If permitted, entrepreneurs may stumble upon many yet unknown innovations to move these industries into the 21st century.

## ENDNOTES

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- <sup>1</sup> *The Origin and Evolution of New Businesses*, Amar Bhide (2000), pg. xiv. See also Compaq and Compaq Canada websites. Compaq's founders were Rod Canion, Jim Harris, and Bill Murto. The company raised \$20 million in venture capital and \$67 million from an IPO.
- <sup>2</sup> In the U.S., Dell Computer has now overtaken Compaq in sales.
- <sup>3</sup> Bhide (2000), pg. xiii. Professorships in entrepreneurship have risen from 18 in 1980 to more than 200 today. Regarding rising student interest, see "The Faces of a New Generation," *The Wall Street Journal*, May 22, 2000. See also *Entrepreneurship: The Past, Present, and Future*, Arnold Cooper, Purdue University.
- <sup>4</sup> *New Venture Creation: Entrepreneurship For the 21st Century*, Jeffrey Timmons (1999), pg. 13. Recent stock market fluctuations may, of course, temper this trend.
- <sup>5</sup> Bhide (2000), pg. 13.
- <sup>6</sup> "The New Economy is Stronger Than You Think", William Sahlman in the *Harvard Business Review*, November 1999, pg. 100.
- <sup>7</sup> Timmons (1999), pg. 5.
- <sup>8</sup> *Business Starts and Stops*, William Dennis, Jr. for Wells Fargo/National Federation of Independent Business, January, 2000. Figures from the NFIB and Jeffrey Timmons may not be directly comparable due to different methodologies used.
- <sup>9</sup> Timmons (1999), pg. 5.
- <sup>10</sup> *How the West Grew Rich*, Nathan Rosenberg and L.E. Birdzell, Jr. (1986), pg. 277.
- <sup>11</sup> See *Entrepreneurial Dynamism and the Success of U.S. High-Tech*, Chris Edwards for the Joint Economic Committee (1999) for a discussion of America's lead in high-tech.
- <sup>12</sup> Timmons (1999), pgs. 8, 81.
- <sup>13</sup> "From GM to Cisco in Just Four Decades," *Business Week*, February 7, 2000.
- <sup>14</sup> *The Millionaire Next Door*, Thomas Stanley and William Danko, 1996.
- <sup>15</sup> *Forbes*, October 9, 2000, pg. 362. 66% of Forbes 400 are entirely self-made, 15% built their fortune with some inherited wealth, and 19% inherited their wealth.
- <sup>16</sup> *Frontier* monthly supplement, *Business Week*, December 6, 1999.
- <sup>17</sup> Sahlman (1999), pg. 105.
- <sup>18</sup> Timmons (1999), pg. 6.
- <sup>19</sup> "From the Ground Floor," Steve Jurvetson in *Red Herring*, April, 2000.
- <sup>20</sup> 20th Anniversary Issue, *Inc*, 1999, pg. 76.
- <sup>21</sup> National Science Foundation data for total U.S. industrial R&D at <www.nsf.gov>.
- <sup>22</sup> *The Economics of Industrial Innovation*, Chris Freeman and Luc Soete (1997), pg. 239.
- <sup>23</sup> See Freeman and Soete (1997), pg. 233. See also Timmons (1999), pgs. 9, 81; and *The New Pioneers*, Thomas Petzinger (1999), pg. 21.
- <sup>24</sup> "Small and Medium Size Enterprises: Local Strength, Global Reach," OECD (2000). See also Freeman and Soete (1997), pg. 225.
- <sup>25</sup> Testimony of Jay Walker, Chairman of Walker Digital Corporation and Founder Priceline.com, before the Joint Economic Committee, June 6, 2000.
- <sup>26</sup> *American Genesis*, Thomas Hughes (1989), pg. 83. See also Freeman and Soete (1997), pg. 50.
- <sup>27</sup> "M&A Century: Same As It Ever Was," *Wall Street Journal*, December 31, 1999.
- <sup>28</sup> *The Entrepreneurial Adventure*, Larry Schweikart (2000), pg. 318.
- <sup>29</sup> Schweikart (2000), pg. 491.
- <sup>30</sup> *Junk Bonds*, Glenn Yago (1991), pg. 25.
- <sup>31</sup> Schweikart (2000), pg. 514.
- <sup>32</sup> "McCaw Comes Calling Again," *Puget Sound Business Journal*, September 23, 1996.
- <sup>33</sup> "Craig McCaw: The Prophet of Telecom," *Business Week*, September 28, 1998.
- <sup>34</sup> Yago (1991).
- <sup>35</sup> "Global Markets, Following U.S., Acquire Taste for Junk," *Wall Street Journal*, August 14, 2000.
- <sup>36</sup> Schweikart (2000), pg. 487.
- <sup>37</sup> *Forbes Greatest Business Stories of All Time*, Daniel Gross editor (1996), pgs. 290, 295.
- <sup>38</sup> Yago (1991), pg. 25.

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- <sup>39</sup> *Forbes* (1996), pg. 330.
- <sup>40</sup> Bhide (2000), pgs. 161, 163. See also Timmons (1999), pg. 9.
- <sup>41</sup> "Money to Burn," *The Economist*, May 27, 2000. Also see "The Faster Factor," Shannon Henry in the *Washington Post*, August 17, 2000.
- <sup>42</sup> Leslie Walker, *Washington Post*, March 2, 2000. See also *The Economist*, May 27 and August 12, 2000.
- <sup>43</sup> "Smash the Venture Cartel," *Forbes*, January 10, 2000.
- <sup>44</sup> "Venture Capital Fund Aims at Ordinary Investor," *The Washington Post*, December 8, 1999. See also "Money to Burn," *The Economist*, May 27, 2000.
- <sup>45</sup> "Adventurous Venture Capital," *The Economist*, May 27, 2000.
- <sup>46</sup> Sahlman (1999), pg. 105.
- <sup>47</sup> *The Sources of Economic Growth*, Richard Nelson (1996), pg. 33.
- <sup>48</sup> "The New Year's Bundle of Jitters," *Business Week*, December 28, 1998.
- <sup>49</sup> "And For the Economy's Next Act," *Business Week*, December 29, 1997. Figures for 1998 and 1999 are measured from 4th quarter to 4th quarter.
- <sup>50</sup> For example, Alexander Graham Bell's telephone was initially considered to be a toy by Western Union's president. See Schweikart (2000), pg. 320.
- <sup>51</sup> *The Innovators Dilemma*, Clayton Christensen (1997), pg. 158.
- <sup>52</sup> Bhide (2000), pg. 17.
- <sup>53</sup> Bhide (2000), pg. 60.
- <sup>54</sup> *The Silicon Boys*, David Kaplan (1999), pg. 239.
- <sup>55</sup> *The New New Thing*, Michael Lewis (2000), pgs. 76-82. See also Kaplan (1999), pg. 233; and see "Click Flicks," *Forbes*, August 7, 2000.
- <sup>56</sup> "Bush to Invoke Content Rules for HDTV Development," *The Journal of Commerce*, June 29, 1992.
- <sup>57</sup> "Iridium Loses Its White Knight," *The Washington Post*, March 4, 2000. See also "Iridium Satellite Network to Flame Out," *Reuters*, March 18, 2000.
- <sup>58</sup> *New York Times*, February 28, 2000. See also *Investors Business Daily*, June 6, 2000.
- <sup>59</sup> Freeman and Soete (1997), pg. 176.
- <sup>60</sup> Freeman and Soete (1997), pgs. 173, 174.
- <sup>61</sup> Christensen (1997), pgs. 108, 109.
- <sup>62</sup> Timmons (1999), pg. 84. See also *Regional Advantage*, Annalee Saxenian (1994), pg. 100.
- <sup>63</sup> Kaplan (1999), pg. 89.
- <sup>64</sup> Freeman and Soete (1997), pg. 127.
- <sup>65</sup> Schweikart (2000), pg. 494.
- <sup>66</sup> Timmons (1999), pg. 84.
- <sup>67</sup> "Survey of the New Economy," *The Economist*, September 23, 2000.
- <sup>68</sup> Freeman and Soete (1997), pg. 242.
- <sup>69</sup> "Big vs. Small: Is Entrepreneurialism Hurting the U.S. by Splintering its Industrial Base," *Time*, September 5, 1988.
- <sup>70</sup> Lester Thurow expressed similarly that the U.S. may have "too much entrepreneurship." See his 1992 *Head to Head*. Other pessimists on entrepreneurship cited by *Time* included Clyde Prestowitz (see his 1988 *Trading Places*) and Charles Ferguson of MIT.
- <sup>71</sup> "Smash the Venture Cartel," *Forbes*, January 10, 2000.
- <sup>72</sup> "Whatever You Call It, Industrial Policy is on the Way," *Business Week*, December 28, 1992. Tyson described herself as a "cautious activist" regarding government policy to maintain America's competitiveness in high-tech. See her *Who's Bashing Whom: Trade Conflict in High-Technology Industries*, Laura D'Andrea Tyson, 1992.
- <sup>73</sup> Other prominent advocates for some sort of industrial policy during the 1980s and early 1990s included Chalmers Johnson, Robert Reich, Ira Magaziner, Kevin Phillips, H. Ross Perot, Clyde Prestowitz, and Lester Thurow.
- <sup>74</sup> *Made in America: Regaining the Competitive Edge*, The MIT Commission on Industrial Productivity with Michael Dertouzos, Richard Lester, and Robert Solow (1989), pg. 260.
- <sup>75</sup> MIT Commission (1989), pg. 261.
- <sup>76</sup> MIT Commission (1989). See comments by Saxenian (1994) pgs. 6, 44, 111.
- <sup>77</sup> MIT Commission (1989), pgs. 64, 255. See comments by Saxenian (1994) pgs. 6, 44, 111.
- <sup>78</sup> Saxenian (1994), pg. 193, footnote 5.
- <sup>79</sup> Saxenian (1994). See also Schweikart (2000), pg. 526.
- <sup>80</sup> Semiconductor Industry Association web page at <[www.semichips.org](http://www.semichips.org)>.

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- <sup>81</sup> MIT Commission (1989), pgs. 55, 57. Also, for example, a major Harvard Business School / Council on Competitiveness study called "Time Horizons" looked into this issue and issued a report in 1992.
- <sup>82</sup> *Head to Head*, Lester Thurow, 1992, pg. 281, 288.
- <sup>83</sup> Paul Krugman in *Fortune*, March 6, 2000, pg. F18.
- <sup>84</sup> For example, see "Nissan's Revival," *OECD Observer*, April 2000.
- <sup>85</sup> *The Zero Sum Solution*, Lester Thurow, 1985, (New York: Simon and Schuster), pgs. 162, 163, 125. See also Thurow's *Head to Head*, 1992, pg. 139.
- <sup>86</sup> MIT Commission (1989), pg. 260.
- <sup>87</sup> MIT Commission (1989), pg. 261.
- <sup>88</sup> Saxenian (1994), pg. 37.
- <sup>89</sup> Kaplan (1999), pgs. 119-145.
- <sup>90</sup> Kaplan (1999), pg. 58.
- <sup>91</sup> Freeman and Soete (1997), pg. 129
- <sup>92</sup> Christensen (1997), pg. 45.
- <sup>93</sup> *Building Companies, Building Communities: Entrepreneurs in the New Economy*, National Commission on Entrepreneurship, July 2000.
- <sup>94</sup> See "What Happened to the Asian Miracle," *Investors Business Daily*, October 29, 1999.
- <sup>95</sup> Entry on "Industrial Policy" in the *Fortune Encyclopedia of Economics*, 1993.
- <sup>96</sup> Saxenian (1994), pg. 204. See also *New Scientist*, May 2, 1992.
- <sup>97</sup> Akio Morita obituary in the *Financial Times*, October 4, 1999. See also *New Scientist*, May 2, 1992.
- <sup>98</sup> *The Zero Sum Solution*, Lester Thurow, 1985 (New York: Simon and Schuster), pg. 285. See also Freeman and Soete (1997), pg. 154.
- <sup>99</sup> See Gilder's *The Spirit of Enterprise* and other books.
- <sup>100</sup> Schweikart (2000), pg. 526. See also *The Economist*, April 10, 1999, pg. 19.
- <sup>101</sup> "MITI Cuts Japan Loose," *Management Today*, January, 1995.
- <sup>102</sup> *Forbes* (1996). See also Schweikart (2000), pg. 538. Xerox's general counsel at the time noted regarding the FTC, "We were telling them about the Japanese and what was coming with increased competition, but they wouldn't listen. They were purists. If you had market share you were evil." Quoted in *Xerox: American Samurai*, Gary Jacobson and John Hillkirk, 1986 (Macmillan Publishing), pg. 72.
- <sup>103</sup> "What Microsoft Could Learn from U.S. vs. IBM," Gary Anthes in *Computerworld*, March 2, 1998.
- <sup>104</sup> "Detroit Plays Catch Up in Race for Hybrid Car," *New York Times*, January 1, 2000.
- <sup>105</sup> "Flights of Folly," *Financial Times*, August 17, 2000. Figure of 9 billion UK pounds converted to U.S. dollars. See also Freeman and Soete (1997), pg. 250.
- <sup>106</sup> "The Visible Hand," Jonathan Rauch in the *National Journal*, July 9, 1994.
- <sup>107</sup> Nelson (1996), pg. 117.
- <sup>108</sup> Schweikart (2000), pg. 307. See also *Fortune*, November 22, 1999, pg. 111; and see Freeman and Soete (1997), pgs. 144, 156.
- <sup>109</sup> Testimony of Dr. Warnock before the Joint Economic Committee, June 6, 2000.
- <sup>110</sup> "Bringing Silicon Valley Inside," Gary Hamel in *Harvard Business Review*, Sept-Oct, 1999.
- <sup>111</sup> Bhide (2000), pg. 145. See also Kaplan (1999), pgs. 195, 196.
- <sup>112</sup> Bhide (2000), pgs. 196-203 describes uncertainty and the types of investment opportunities pursued by large corporations, VCs, and entrepreneurs.
- <sup>113</sup> Timmons (1999), pg. 76.
- <sup>114</sup> See Bhide (2000), pgs. 196-203.
- <sup>115</sup> High inflation, crime, corruption, and other government failings raise risks for entrepreneurs substantially. Countries and regions with these problems see little new business investment. For example, a study by Shang-Jin Wei found that government corruption created great uncertainty for potential foreign business investors, creating a strikingly large and negative impact on inward foreign direct investment. (*NBER Working Paper 6255*, November 1997). A recent domestic example of how politics creates uncertainty for businesspeople is the drop in biotechnology share prices in May 2000 in response to adverse statements on the industry by President Clinton. After the plunge, one investment advisor noted, "I think this is a brilliant illustration of what happens when government policy changes suddenly ... A critical component of technology innovation and business innovation is policy stability, not just in patent rights, but also in taxes, property rights, monetary policy and international trade." Quoted in "Nasdaq Swoons After Plea; Point Drop is 2nd Biggest," *Washington Post*, March 15, 2000.
- <sup>116</sup> Bhide (2000), pg. 5.

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- <sup>117</sup> As quoted in a book review of Gilder's *The Spirit of Enterprise* in *Policy Review*, Heritage Foundation, Fall 1984.
- <sup>118</sup> See *An Evolutionary Theory of Economic Change*, Richard Nelson and Sidney Winter (1982), for a discussion of the shortcomings of orthodox economic theory.
- <sup>119</sup> See discussion in "A Thinkers' Guide," *The Economist*, April 1, 2000. An interesting example of how entrepreneurs in the Internet world are solving problems is eBay's efforts to reduce fraud to retain its reputation, see "eBay Changes How the Wild Web is Run," *Washington Post*, November 28, 1999.
- <sup>120</sup> This section borrows from discussion in Bhide (2000). See also the "Entrepreneurship" entry by Mark Casson in *The Fortune Encyclopedia of Economics*, 1993.
- <sup>121</sup> "Creativity and/or Alertness: A Reconsideration of the Schumpeterian Entrepreneur," Israel Kirzner, *The Review of Austrian Economics*, Volume 11, No. 1/2, 1999.
- <sup>122</sup> "Creativity and/or Alertness: A Reconsideration of the Schumpeterian Entrepreneur," Israel Kirzner, *The Review of Austrian Economics*, Volume 11, No. 1/2, 1999.
- <sup>123</sup> Holcombe (1998), pg. 56 reconciles this view with the Kirznerian view which sees the entrepreneur moving the economy toward equilibrium.
- <sup>124</sup> "Entrepreneurship," Mark Casson in *The Fortune Encyclopedia of Economics*, 1993.
- <sup>125</sup> Frank Knight thought that profits stemmed from two sources: uncertainty and monopoly. See *Fortune*, March 6, 2000, pg. F-43.
- <sup>126</sup> *The New American Evolution: The Role and Impact of Small Firms*, Small Business Administration, June 1998.
- <sup>127</sup> For a discussion of evolutionary economic theory, see Nelson and Winter (1982); or *Evolutionary Economics: An Application of Schumpeter's Ideas*, Edited by Horst Hanusch, 1988. Also of interest is "The Praxeological Entrepreneur vs the Promoter: An Assessment of Ludwig von Mises on Entrepreneurship," by Professor J. Patrick Gunning, August, 1998.
- <sup>128</sup> Nelson (1996), pg. 53.
- <sup>129</sup> Quoted in Petzinger (1999), pg. 18.
- <sup>130</sup> Nelson (1996), pg. 114.
- <sup>131</sup> Rosenberg and Birdzell (1986), pg. 331.
- <sup>132</sup> Joseph Schumpeter identified five types of innovation: new products, new methods of production, new markets, new sources of supply, and new business models. See Nelson and Winter (1982), pg. 277.
- <sup>133</sup> Christensen (1997), pgs. 37, 47. See also Bhide (2000), pg. 227 for a discussion of management innovation.
- <sup>134</sup> Freeman and Soete (1997), pg. 234.
- <sup>135</sup> Rosenberg and Birdzell (1986), pg. 258.
- <sup>136</sup> Christensen (1997). Note Christensen distinguishes "radical" innovations from "disruptive" innovations. I have used the words interchangeably.
- <sup>137</sup> "Bringing Silicon Valley Inside," Gary Hamel in *Harvard Business Review*, Sept-Oct, 1999.
- <sup>138</sup> Schweikart (2000).
- <sup>139</sup> Schweikart (2000), pg. 320.
- <sup>140</sup> Christensen (1997), pgs. 61, 75.
- <sup>141</sup> Freeman and Soete (1997), pgs. 244, 255, 273.
- <sup>142</sup> Freeman and Soete (1997), pgs. 244, 273.
- <sup>143</sup> Christensen (1997), pg. 56.
- <sup>144</sup> Timmons (1999), pgs. 9, 81.
- <sup>145</sup> Based on discussion in *Forbes* (1996); MIT (1989), pg. 271; and other accounts.
- <sup>146</sup> Bhide (2000), pg. 148.
- <sup>147</sup> *Forbes* (1996), pg. 251.
- <sup>148</sup> Kaplan (1999), pgs. 64-72.
- <sup>149</sup> Christensen (1997).
- <sup>150</sup> Schweikart (2000), pgs. 456-458.
- <sup>151</sup> Christensen (1997), pgs. 87-93.
- <sup>152</sup> "From Suburban Roots to a Global Ambition," *Washington Post*, June 4, 2000. AOL's co-founder with Case was Jim Kimsey.
- <sup>153</sup> "Companies Seen as Too Cautious on Innovation," *Financial Times*, December 7, 1999.
- <sup>154</sup> Bhide (2000), pgs. 39, 197.
- <sup>155</sup> Bhide (2000), pg. 198.
- <sup>156</sup> "Look at Roaring '20s Finds Optimistic Parallels," *Wall Street Journal*, June 12, 2000.
- <sup>157</sup> Bhide (2000), pgs. 43, 131.

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- <sup>158</sup> Bhide (2000), pg. 197.
- <sup>159</sup> *The Economist*, December 4, 1999, pg. 61.
- <sup>160</sup> *Washington Post*, March 12, 2000.
- <sup>161</sup> "Money to Burn," *The Economist*, May 27, 2000. See also *Wall Street Journal*, February 8, 2000, pg. C1.
- <sup>162</sup> Rosenberg and Birdzell (1986), pg. 277.
- <sup>163</sup> Schweikart (2000), pg. 486.
- <sup>164</sup> Schweikart (2000), pg. 487.
- <sup>165</sup> "A Thinkers Guide," *The Economist*, April 1, 2000.
- <sup>166</sup> Rosenberg and Birdzell (1986), pg. 27.
- <sup>167</sup> Freeman and Soete (1997), pgs. 138, 141, 143.
- <sup>168</sup> Freeman and Soete (1997), pg. 141. Schweikart (2000), pg. 306. James Flink, *The Automobile Age*, 1988.
- <sup>169</sup> *Investors Business Daily*, November 10, 1999.
- <sup>170</sup> Christensen (1997), pg. 111.
- <sup>171</sup> *Investors Business Daily*, December 8, 1999. See also Freeman and Soete (1997), pg. 58.
- <sup>172</sup> *Investors Business Daily*, December 8, 1999.
- <sup>173</sup> *Statistical Abstract of the United States 1902*, U.S. Bureau of Statistics, 1903.
- <sup>174</sup> "The Prospering Fathers," Paul Johnson in *Commentary*, July, 1999. See also *Investors Business Daily*, December 8, 1999.
- <sup>175</sup> Bhide (2000), pg. 35.
- <sup>176</sup> BBC news website profile of Branson.
- <sup>177</sup> "Bringing Silicon Valley Inside," Gary Hamel in *Harvard Business Review*, Sept-Oct, 1999.
- <sup>178</sup> "Red Baron," *Forbes*, July 3, 2000.
- <sup>179</sup> *Investors Business Daily*, March 13, 2000.
- <sup>180</sup> See discussion in Freeman and Soete (1997), pg. 250.
- <sup>181</sup> Kaplan (1999), pg. 193.
- <sup>182</sup> "Qualcomm Finds Riches Linking Internet Hand-Held Devices," *Washington Post*, February 20, 2000. See also "Qualcomm's Dr. Strangelove," *The Economist*, June 17, 2000.
- <sup>183</sup> *Business Week*, March 6, 2000.
- <sup>184</sup> Celera was set up as an off-shoot of PE Corp, a laboratory equipment company which supplied the gene sequencing machines. See *Forbes*, February 21, 2000, pg. 99.
- <sup>185</sup> *New York Times*, June 27, 2000.
- <sup>186</sup> See "The Race to Crack the Gene Code," *Los Angeles Times*, October 29, 1998; "In Genome Race, Government Vows to Move Up Finish," *New York Times*, September 15, 1998; "Scientists Speed Up Timetable for Mapping Human Genes," *Washington Post*, September 15, 1998.
- <sup>187</sup> Testimony of Dr. Craig Venter before the Joint Economic Committee, June 7, 2000.
- <sup>188</sup> Christensen (1997), pg. 135.
- <sup>189</sup> Christensen (1997), pg. 147, 160.
- <sup>190</sup> Bhide (2000), pg. 15.
- <sup>191</sup> Bhide (2000), pgs. 62, 63.
- <sup>192</sup> See discussion in Bhide (2000), pg. 59, 60.
- <sup>193</sup> Book review of *Amazon.com* in the *New York Times*, June 27, 2000.
- <sup>194</sup> "The New Imperialists: Jeff Bezos: Amazon Man," *Washington Post*, September 3, 2000.
- <sup>195</sup> Freeman and Soete (1997), pgs. 140, 194. In 1900, there were more steam-powered and electric-powered cars sold than gasoline-powered, see "100 Years of Innovation," *Business Week*, Summer 1999, pg. 35.
- <sup>196</sup> *Investors Business Daily*, December 3, 1999.
- <sup>197</sup> Timmons (1999), pg. 85.
- <sup>198</sup> Bhide (2000), pgs. 169-185.
- <sup>199</sup> Bhide (2000), pg. 179.
- <sup>200</sup> For a discussion of this issue, see *Entrepreneurial Dynamism and the Success of U.S. High-Tech*, Chris Edwards for the Joint Economic Committee, October, 1999.
- <sup>201</sup> Lewis (2000), pgs. 43, 188
- <sup>202</sup> Freeman and Soete (1997), pgs. 200, 217, 261. See also Rosenberg and Birdzell (1986), pg. 262.
- <sup>203</sup> The distinction between "invention" and "innovation" goes back to Schumpeter. See Nelson and Winter (1982), pg. 263.
- <sup>204</sup> Freeman and Soete (1997), pg. 301.

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- <sup>205</sup> *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor*, David Landes (1999).
- <sup>206</sup> Landes (1999), pg. 54.
- <sup>207</sup> Rosenberg and Birdzell (1986), pgs. 87, 88, 137, 138. Landes (1999), pgs. 56, 57.
- <sup>208</sup> *The Longcase Clock*, Eric Bruton, 1964. (London: Arco Publications).
- <sup>209</sup> Landes (1999), pg. 50.
- <sup>210</sup> Landes (1999), pg. 50.
- <sup>211</sup> Book review of Paul Johnson's *The Renaissance*, *Wall Street Journal*, August 23, 2000.
- <sup>212</sup> *The Longcase Clock*, Eric Bruton, 1964. (London: Arco Publications).
- <sup>213</sup> Landes (1999), pg. 59.
- <sup>214</sup> *Monitoring the World Economy, 1820-1992*, Angus Maddison for the OECD, 1995.
- <sup>215</sup> Etienne Balazs quoted by Landes (1999), pg. 57.
- <sup>216</sup> Rosenberg and Birdzell (1986), pg. 88, 89.
- <sup>217</sup> Landes (1999), pg. xviii.
- <sup>218</sup> Rosenberg and Birdzell (1986), pgs. 264, 332. They note, "The long growth in scientific and technical knowledge could not have been transformed into continuing economic growth had Western society not enjoyed a social consensus that favored the everyday use of the products of innovation."
- <sup>219</sup> *Monitoring the World Economy, 1820-1992*, Angus Maddison for the OECD, 1995. Rosenberg and Birdzell (1986) date the Western acceleration of growth from about the mid-fifteenth century onwards.
- <sup>220</sup> Rosenberg and Birdzell (1986), pg. 261.
- <sup>221</sup> *Monitoring the World Economy, 1820-1992*, Angus Maddison for the OECD, 1995.
- <sup>222</sup> As quoted in *The Victorian Internet*, Tom Standage (1998), pg. 41.
- <sup>223</sup> Standage (1998), pg. 75.
- <sup>224</sup> Tom Standage (1998), pgs. 73, 84, 88. The first cross-Atlantic cable had been laid in 1858, but it failed after only a month of operation.
- <sup>225</sup> Rosenberg and Birdzell (1986), pg. 250.
- <sup>226</sup> *Fortune*, November 22, 1999, pg. 174.
- <sup>227</sup> James Flink, *The Automobile Age*, 1988.
- <sup>228</sup> Comments by Warren Buffett in *Fortune*, November 22, 1999, pg. 220.
- <sup>229</sup> "Dotty About Dot Commerce," *Economist*, February 26, 2000, pg. 5.
- <sup>230</sup> Forrester Research *Press Release*, April 11, 2000.
- <sup>231</sup> Freeman and Soete (1997), pg. 239. See also Nelson (1996), pg. 115.
- <sup>232</sup> Nelson (1996), pg. 39.
- <sup>233</sup> Tom Standage (1998), pg. 58.
- <sup>234</sup> *Statistical Abstract of the United States 1902*, U.S. Bureau of the Census, 1903, pg. 418. See also Schweikart (2000), pg. 319.
- <sup>235</sup> Tom Standage (1998), pgs. 171, 119.
- <sup>236</sup> Tom Standage (1998), pg. 202.
- <sup>237</sup> Tom Standage (1998), pg. 197.
- <sup>238</sup> Tom Standage (1998), pg. 204.
- <sup>239</sup> "Look at Roaring '20s Finds Optimistic Parallels," *Wall Street Journal*, June 12, 2000.
- <sup>240</sup> *Financial Times*, March 1, 2000.
- <sup>241</sup> Noted by Saxenian (1994), pgs. 87, 118.
- <sup>242</sup> Freeman and Soete (1997), pg. 239.
- <sup>243</sup> OECD (2000).
- <sup>244</sup> Mergers which anticipated the Glass-Steagall repeal were Citicorp/Travelers in 1998 and Bankers Trust/Alex Brown in 1997. See "An Industry is Liberated from the Constraints of the Past," *Financial Times*, January 1, 2000.
- <sup>245</sup> Interview with James Leach, *Investors Business Daily*, December 8, 1999. Federal Reserve Board Chairman Alan Greenspan has expressed similar views, see *Financial Times*, September 19, 2000.
- <sup>246</sup> "Markets Compute Response to High-Tech Rivals," *Washington Post*, December 5, 1999.
- <sup>247</sup> "The Energetic Messiah," *The Economist*, June 3, 2000.
- <sup>248</sup> Lewis (2000). Healthon/WebMD advertises that 25 percent of the nation's \$1 trillion in health care costs is "pure waste."
- <sup>249</sup> "Online Healthcare is Just What the Patient Ordered," *Financial Times*, February 20, 2000.
- <sup>250</sup> *Investors Business Daily*, November 10, 1999. Also, Schweikart (2000), pg. 122. See also "The Challenge To the U.S. Postal Monopoly, 1839-1851," Kelly Olds, *Cato Journal*, Vol. 15, No. 1.

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<sup>251</sup> "The Postal Service: One Hot Property," *Washington Post*, January 19, 2000.

<sup>252</sup> "Universal Service Without A Monopoly," Robert Cohen et al., U.S. Postal Rate Commission, November 1999.

<sup>253</sup> "Holiday Pioneers Foresee \$100,000 Star Treks," *Financial Times*, February 20, 2000. See also *Wired*, January 2000, pg. 119.

<sup>254</sup> "Holiday Pioneers Foresee \$100,000 Star Treks," *Financial Times*, February 20, 2000.

<sup>255</sup> "Privatize NASA Now," *Wired*, quoting NASA administrator Dan Goldin, September 25, 1999.

<sup>256</sup> "MirCorp Aims for Stratosphere With IPO," *Washington Post*, October 16, 2000.

<sup>257</sup> Rosenberg and Birdzell (1986), pgs. 267, 297.

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