

Entrepreneurship in the United States, 1865-1920

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1. A Period of Rapid Expansion

The half-century or so following the Civil War was a period of extraordinarily rapid economic growth in the United States. Real gross domestic product (GDP) multiplied more than seven times between 1865 and 1920, and real per capita product more than doubled. As the much higher growth rates of total compared to per capita GDP suggest, the economy expanded more by adding new inputs than it did by increasing productivity. Nevertheless, the rate of increase in per capita product (averaging about 1.7 percent per year over the entire period 1870-1920) was higher than ever before in U.S. history, and total factor productivity grew from an index value of 51.0 in 1889, the first year for which figures are available, to 81.2 in 1920 (1929=100). These productivity figures, moreover, underestimate the extent of technological progress. Because they are calculated as residuals, they do not capture improvements that were embodied in capital or in other inputs to the production process.¹

Although many factors contributed to the extensive growth of the period, including high rates of immigration and a substantial rise in the savings rate, perhaps the most important was the expansion and improvement of the nation's transportation and communications network. This development permitted the abundant agricultural and

¹ Susan B. Carter, et al., 2006, *Historical Statistics of the of the United States: Earliest Times to the Present, Millennial Edition* (Cambridge: Cambridge University Press), Vol. 3, pp. 3, 5, 23-25, 463.

mineral resources of the western parts of the country to be brought into profitable production. It also contributed to the rise of per capita income, most obviously by making it possible to exploit economies of scale and to concentrate production in areas of the country that for one reason or another had a comparative advantage. During this period industry became both more regionally specialized and increasingly dominated by large-scale enterprises.²

Another important way in which improvements in transportation raised per capita income was by stimulating technological innovation and entrepreneurship.³ As entrepreneurs responded to the new opportunities for profit provided by the country's rapidly growing markets, per capita patenting rates soared (see Figure 1) and technology advanced in directions that were so novel as to constitute a Second Industrial Revolution. Entrepreneurs formed startup enterprises to exploit cutting-edge developments in new industries such as steel, electricity, chemicals, and automobiles, pushing the frontiers of technological knowledge continually outward and dramatically transforming American society in the process. Indeed, so many people came up with so many new technological ideas and founded so many new businesses during this period that it has generally been considered a golden age for both the independent inventor and the entrepreneur.⁴

² Sukkoo Kim, 1995, "Expansion of Markets and the Geographic Distribution of Economic Activities: The Trends in U.S. Regional Manufacturing Structure, 1860-1987," *Quarterly Journal of Economics*, 110 (Nov.): 881-908; and Alfred D. Chandler, Jr., 1977, *The Visible Hand: The Managerial Revolution in American Business* (Cambridge: Harvard University Press).

³ For a demonstration using data for an earlier period, see Kenneth L. Sokoloff, 1988, "Inventive Activity in Early Industrial America: Evidence from Patent Records, 1790-1846," *Journal of Economic History*, 48 (Dec.): 813-30.

⁴ Thomas P. Hughes, 1989, *American Genesis: A Century of Invention and Technological Enthusiasm, 1870-1970* (New York: Viking); Joseph A. Schumpeter, 1942, *Capitalism, Socialism, and Democracy* (New York: Harper & Row).

2. The Entrepreneur's Status in American Society

If ever there was a time or place when entrepreneurs were the most admired figures in society, it was the United States during the late nineteenth century. Americans knew the names and avidly followed the exploits of the period's "captains of industry." They devoured the rags-to-riches novels of Horatio Alger, poured over P. T. Barnum's *The Art of Money-Getting* and other success manuals, and turned out by the hundreds of thousands to hear the Reverend Russell Conwell deliver his how-to-get-rich lecture, "Acres of Diamonds." There was no higher goal for a young American male to pursue during this period than to become a "self-made man"—to make a great deal of money through dint of his own hard work and "pluck."⁵

This was the era when Social Darwinist ideas were in the ascendancy, and they were more influential in the U.S. than anywhere else. According to this view, business people were engaged in a competitive struggle. Only the fittest would succeed. Moreover, because the qualities that Americans of the time thought determined who was fittest were the Protestant virtues of hard work, thrift, and probity, success was a sign of a man's moral worth.⁶ Judgments of creditworthiness during this period were primarily judgments of character. Men who failed in business had not only proved themselves

⁵ Irvin G. Wyllie, 1954, *The Self-Made Man in America: The Myth of Rags to Riches* (New Brunswick, NJ: Rutgers University Press); Edward Chase Kirkland, 1956, *Dream and Thought in the Business Community, 1860-1900* (Ithaca, NY: Cornell University Press); John A. Garraty, 1968, *The New Commonwealth, 1877-1890* (New York: Harper & Row), p. 16; Thomas C. Cochran, 1972, *Business in American Life: A History* (New York: McGraw-Hill), pp. 170-76; Judy Hilkey, 1997, *Character is Capital: Success Manuals and Manhood in Gilded Ages America* (Chapel Hill: University of North Carolina Press).

⁶ Richard Hofstadter, 1955, *Social Darwinism in American Thought* (Rev. edn.; Boston: Beacon Press); Wyllie, 1954, *Self-Made Man in America*; Hilkey, 1997, *Character is Capital*.

unfit in a Darwinian sense, they had demonstrated serious moral deficiencies.⁷ This idea that failure reflected inner weaknesses was so powerful that movements like the Populists had to rebuild the self-esteem of farmers hit hard by forces beyond their control in order to mobilize them politically. The Populists organized networks of cooperative enterprises in order to relieve farmers' economic distress but also with the aim of substituting an ethic of mutual self-help for the ideal of the self-made man.⁸

The ruthlessness with which the “robber barons” of the period pursued their ambitions undercut to some extent the equation of success and virtue.⁹ Ida Tarbell's character studies of John D. Rockefeller, published in contemporary magazines, portrayed the oil magnet as a commercial Machiavellian, “the victim of a money-passion” that drove him to get ahead by any means possible, however dishonorable. Though Rockefeller later gave away an enormous amount of money, he could never completely shake this negative public image.¹⁰ By contrast, Andrew Carnegie overcame the damage to his reputation inflicted by events like the Homestead strike of 1892 by embracing of the “Gospel of Wealth” and using philanthropy strategically to reassert the connection between success and virtue. After his death in 1919, he was hailed as the

⁷ Scott A. Sandage, 2005, *Born Losers: A History of Failure in America* (Cambridge: Harvard University Press); Rowena Olegario, 2006, *A Culture of Credit: Embedding Trust and Transparency in American Business* (Cambridge: Harvard University Press), pp. 80-118.

⁸ Lawrence Goodwyn, 1978, *The Populist Moment: A Short History of the Agrarian Revolt in America* (New York: Oxford University Press).

⁹ On this point, see Alan Trachtenberg, 1982, *The Incorporation of America: Culture and Society in the Gilded Age* (New York: Hill and Wang), p. 78-86.

¹⁰ Tarbell's articles are quoted in David M. Chalmers, 1966, “Introduction to the Torchbook Edition,” in Ida M. Tarbell, *The History of the Standard Oil Company*, ed. Chalmers (New York: Harper & Row), p. xv.

“personification of ‘Triumphant Democracy,’” and leaders from all over the world paid tribute to his character and generosity.¹¹

Of course, the number of people who actually rose all the way from rags to riches was very small. Studies of the origins of the country’s business leaders showed that the vast majority had middle- or even upper-class backgrounds.¹² Nonetheless, there was significant upward mobility during this period, and the extent of this mobility seems to have been great enough to give real substance to the myth. After studying iron, locomotive and machinery manufacturers in nineteenth-century Patterson, New Jersey, Herbert Gutman concluded, that “so many successful manufacturers who had begun as workers walked the streets of that city” that the idea that “‘hard work’ resulted in spectacular material and social improvement” was entirely believable.¹³ Such examples were powerful incentives to entrepreneurship because they showed that the way to move upward in society was to start one’s own business. Indeed, in the late nineteenth century to be an employee (even a genteel, white-collar employee) was to forsake a life of striving for a condition of “dependency”—itself a sign of moral failing.¹⁴

¹¹ Quoted in Joseph Frazier Wall, 1970, *Andrew Carnegie* (New York: Oxford University Press), p. 1043.

¹² See especially the essays by William Miller and Frances W. Gregory and Irene Neu, 1962, in *Men in Business: Essays in the History of Entrepreneurship*, ed. Miller (Cambridge: Harvard University Press), pp. 193-211, 309-28. For a summary of other studies, see Herbert G. Gutman, 1966, *Work, Culture, and Society in Industrializing America* (New York: Random House), pp. 211-14. As Pamela Walker Laird, 2006, has shown, most successful businessmen of the period were not really self-made. They received a lot of assistance from established business leaders who took an interest in their careers. Typically, however, they erased this part of the story from their narratives of their careers. See *Pull: Networking and Success since Benjamin Franklin* (Cambridge: Harvard University Press).

¹³ Gutman, 1966, *Work, Culture, and Society*, p. 232. On rates of social mobility more generally, see Joseph P. Ferrie, 2005, “The End of American Exceptionalism? Mobility in the U.S. Since 1850,” NBER Working Paper 11324.

¹⁴ On this point, see especially Cindy Sondik Aron, 1987, *Ladies and Gentlemen of the Civil Service: Middle Class Workers in Victorian America* (New York: Oxford University Press); and Jocelyn Wills, 2003, “Respectable Mediocrity: The Everyday Life of an Ordinary American Striver, 1876-1890,” *Journal of Social History*, 37 (Winter): 323-49.

3. Institutions and the Role of Government in the Aftermath of the Civil War

As the previous chapter emphasized, the Constitution facilitated entrepreneurship by creating the largest free-trade zone in the world, by prohibiting state governments from abrogating contracts or tampering with the value of money, and by giving the federal government the authority to create a system of intellectual property rights. Although the federal government initially undertook to play an ambitious role in the country's economic development, constitutional scruples and sectional politics quickly limited its activities. State governments were not similarly handicapped, however, and from the late eighteenth century on, they played an active role in the economy, particularly in the area of transportation improvements. During the 1820s and 1830s, as the previous chapter showed, states invested in, or guaranteed the debt obligations of, privately organized road, canal, and railroad companies. Some states even built and operated transportation systems as public works.

Some of these projects were ill-conceived, and after several states defaulted on their bonded debt during the depression that followed the Panic of 1837, there was growing political opposition to such a direct role for government in economic development. Although the prevailing sentiment was that infrastructural projects were best left to private enterprise, many state and local governments nonetheless continued to provide financial support to railroad and other transportation companies in the decades that followed.¹⁵ During the Civil War, moreover, the withdrawal from Congress of southern legislators (who had vehemently opposed federal transportation projects) freed the national government to resume a promotional role. Congress chartered the Union and

¹⁵ See George Rogers Taylor, 1951, *The Transportation Revolution, 1815-1860* (White Plains, NY: M. E. Sharpe); and Louis Harz, 1948, *Economic Policy and Democratic Thought: Pennsylvania, 1776-1860* (Cambridge: Harvard University Press).

Central Pacific Railroads to build the first transcontinental railroad in 1862 and provided the two companies with financial aid in the form of land grants and loan guarantees. A flurry of charters and land grants for additional transcontinentals followed until a series of corruption scandals once again dampened enthusiasm for such governmental initiatives.¹⁶

The most notorious of these scandals involved the Crédit Mobilier Company, a construction company formed by the directors of the Union Pacific to build the railroad. Crédit Mobilier charged its parent company what seemed to be an exorbitant amount for each mile of road it built and made its owners rich. Although disgruntled stockholders challenged the arrangement in court, their suit attracted little attention until the run-up to the presidential campaign of 1872, when a newspaper revealed that the “railroad ring” had bribed influential Congressmen by giving them Crédit Mobilier shares. Simple fraud was not front-page news, but bribery was.¹⁷ The scandal awakened deep-seated fears that the nation’s democratic institutions were being undermined by economic corruption. Americans traditionally held their politicians in low-esteem, and under normal circumstances kept the resources they could command, especially at the federal level, quite limited. The Civil War, however, had necessitated an enormous expansion of the scope of the federal government’s activities, creating new opportunities for graft. The Crédit Mobilier scandal combined with revelations about corruption in the newly reconstructed state governments of the postbellum South to bring a hasty end, not only to

¹⁶ See Mark Wahlgren Summers, 1993, *The Era of Good Stealings* (New York: Oxford University Press).

¹⁷ David Haward Bain, 1999, *Empire Express. Building the First Transcontinental Railroad* (New York: Viking). See also Summers, 1993, *Era of Good Stealings*.

federal transportation projects, but to most of the government's new activities, including Reconstruction itself.¹⁸

3.1. Ongoing Promotional Activities of the Federal Government

Although the federal government's involvement in the economy receded in the late nineteenth century, some programs that were conducive to entrepreneurship survived the post-Reconstruction retrenchment. Land policy is a good example. Congress had passed the Homestead Act in 1862, enabling settlers to acquire 160 acres of public land in the Western portions of the United States essentially for free on condition that they live on the land for at least five years. Subsequently, the terms of the legislation were liberalized so that under some conditions settlers could acquire greater amounts of land or gain title to their land after a shorter period of residence. Special acts were also passed that granted land to farmers in exchange for planting trees or investing in irrigation. Farmers took entrepreneurial advantage of these favorable incentives to claim on average more than ten million acres of public land each year between 1870 and 1920.¹⁹

Successful cultivation of these western lands required the development of new farming techniques and seed stocks. Here too the federal government played an important role. During the first half of the nineteenth century the states had funded some research on farming practices, and the federal government had joined this effort, sponsoring experimentation with new seed varieties and cultivation techniques under the auspices of the U.S. Patent Office. One of the main purposes of the new Department of

¹⁸ John Joseph Wallis, 2006, "The Concept of Systematic Corruption in American History," in *Corruption and Reform: Lessons from America's Economic History*, ed. Edward L. Glaeser and Claudia Goldin (Chicago: University of Chicago Press), pp. 23-62.

¹⁹ Jeremy Atack and Peter Passell, 1994, *A New Economic View of American History* (2nd edn.; New York: W. W. Norton), pp. 256-60.

Agriculture, established in 1862, was to continue and extend this effort. Similarly, the Morrill Act of the same year created a system of land grant colleges, whose mission was to conduct research on improved farming practices and transmit this knowledge to their students. Government funding for the creation and dissemination of new agricultural knowledge increased further with the passage in 1887 of the Hatch Act, which provided financial support for a system of agricultural experiment stations, and again in 1914 with the Smith-Lever Act, which funded the agricultural extension service.²⁰

As Alan Olmstead and Paul Rhode have shown, this complex of agricultural research institutions provided critical support for the many thousands of farmers who risked everything to move onto the western prairies and plains during the second half of the nineteenth century. Guided by (mostly) government sponsored research in new seed varieties, farmers tried out new types of grain as they coped with the harsh environmental conditions of the West. Less than 10 percent of the acreage planted in wheat in 1919 consisted of varieties that U.S. farmers had sowed before the Civil War. More than 30 percent was planted in varieties introduced in the 1870s and another nearly 20 percent in types first used during the 1880s and 1890s. Olmstead and Rhode estimate that if farmers had not planted these new seed varieties, yields in Western agriculture would have been at least a third lower in 1909 than they actually were and that losses from insect damage and plant diseases would have further reduced output to about half of its actual level. Overall, they calculate, biological innovation accounted for about half of the gain in output per unit of labor that occurred between 1839 and 1909. Most of the rest they

²⁰ Wallace E. Huffman, 1998, "Modernizing Agriculture: A Continuing Process," *Daedalus*, 127 (Fall): 159-86; Alan L. Olmstead and Paul W. Rhode, 2002, "The Red Queen and the Hard Reds: Productivity Growth in American Wheat, 1800-1940," *Journal of Economic History*, 62 (Dec.): 939-66.

attribute to the adoption of the mechanized technologies discussed in the previous chapter.²¹

The other economic activity to receive substantial government support in the late nineteenth century was mining. Federal policy encouraged the exploitation of mineral resources in the West by granting property rights to public lands to those who first laid claim to, and worked, mineral deposits. This policy was strikingly different from the more common practice internationally of treating mineral resources as the property of the state, and it gave rise to a type of entrepreneur who seems to have been uniquely American—the prospector.²² The government also assisted prospectors by conducting geological surveys that helped them locate valuable resources. As in the case of agricultural research, funding initially came from the states during the first half of the nineteenth century, though the national government financed exploratory expeditions by the army's Corps of Topographical Engineers. After the Civil War the Corps' "Geological Exploration of the Fortieth Parallel" provided assessments of mining methods and equipment as well as mapped the location of mineral resources. Then, in 1879, Congress expanded these efforts by founding of the U.S. Geological Survey. Many of the engineers who staffed the Survey were trained at land grant colleges, which also supplied experts to private mining companies. The combined stimulus to discovery that these policies provided helped catapult the U.S. into the position of the world's leading

²¹ Olmstead and Rhode, 2002, "The Red Queen."

²² Gary D. Libecap, 1979, "Government Support of Private Claims to Public Minerals: Western Mineral Rights," *Business History Review*, 53 (Autumn): 364-85; Paul A. David and Gavin Wright, 1997, "Increasing Returns and the Genesis of American Resource Abundance," *Industrial and Corporate Change*, 6 (March): 217.

mineral producer, with a share of global output that greatly exceeded its proportion of resources in the ground.²³

3.2. Financial Institutions

For a quarter century after the demise of the Second Bank of the United States in 1836, the federal government neither chartered banks nor regulated them. The exigencies of Civil War finance induced a change in policy, however. Beginning in 1862, Congress passed a series of National Banking Acts that induced most existing banks to exchange their state charters for national ones. The legislation taxed notes of state banks out of existence, but national banks could issue currency in the form of national banknotes backed by holdings of U.S. government bonds. The federal government thus aimed to achieve two policy goals at the same time: to create a market for its war debt; and to provide the country with a uniform currency that, unlike the hodgepodge of state banknotes that had made up the bulk of the money supply in the antebellum era, would circulate everywhere at par.

Although the creation of a uniform national currency undoubtedly lowered transactions costs and facilitated the growth of a national market, the National Banking System suffered from serious structural flaws that increased the financial instability of the economy. The flaws were a direct result of the political influence that interested groups had exerted during the process of drafting the legislation. For example, at the behest of large northeastern (particularly New York) banks, the legislation specified that ordinary banks could hold their reserves in interest-bearing accounts in banks in designated

²³ David and Wright, 1997, "Increasing Returns."

reserve cities, which in turn could hold their reserves in interest-bearing accounts in banks in the City of New York.²⁴ The result of this pyramiding of reserves was to increase the vulnerability of the entire system to bank failures in New York. Similarly, small banks' efforts to protect themselves against competition from larger banks resulted in a prohibition against branching, denying banks an important tool that they could have used to diversify their portfolios against local shocks.²⁵ Not surprisingly, repeated crises disrupted the financial system over the next half century until finally Congress replaced the National Banking System with the more stable Federal Reserve System in 1913.²⁶

National Banks came under the regulatory authority of the U.S. Comptroller of the Currency who subjected them to regular examinations to insure that they adhered to mandated reserve requirements. The Comptroller also enforced a set of rules that aimed to bolster the soundness of the financial system by limiting banks' business to short-term commercial lending.²⁷ Entrepreneurially minded financiers who found the federal rules too restrictive got around them by persuading state governments to charter novel types of financial institutions. The most important were the so-called trust companies. Initially formed to administer the estates of wealthy families, they quickly evolved into intermediaries that played an important role in underwriting securities issues and

²⁴ David M. Gische, 1979, "The New York City Banks and the Development of the National Banking System, 1860-1870," *American Journal of Legal History*, 23 (Jan.): 21-67.

²⁵ See, for example, Charles W. Calomiris, 1990, "Is Deposit Insurance Necessary? A Historical Perspective," *Journal of Economic History*, 50 (June): 283-95.

²⁶ See Robert Craig West, 1974, *Banking Reform and the Federal Reserve, 1863-1923* (Ithaca, NY: Cornell University Press); Eugene Nelson White, 1983, *The Regulation and Reform of the American Banking System, 1900-1929* (Princeton, NJ: Princeton University Press); James Livingston, 1986, *Origins of the Federal Reserve System: Money, Class, and Corporate Capitalism, 1890-1913* (Ithaca, NY: Cornell University Press).

²⁷ Naomi R. Lamoreaux, 1994, *Insider Lending: Banks, Personal Connections, and Economic Development in Industrial New England* (New York: Cambridge University Press), pp. 107-32.

financing firms in Second Industrial Revolution industries.²⁸ A more general consequence of the growth of state-chartered financial institutions was to reduce monopoly power in local credit markets, lowering the cost of borrowing in regions that had previously been underserved by banks and reducing interest rate differentials across states.²⁹ Although this competition between the states and the federal government might thus be seen as conducive to entrepreneurship, it also spurred governments to lower reserve and capital requirements and tolerate more risky lending practices.³⁰

Banking was subject at least to minimal government regulation during the late nineteenth and early twentieth century. The securities markets were not, and problems of asymmetric information seriously limited the demand for equities. Firms that issued securities generally did not publish balance statements, let alone audited ones, so there was no way of getting reliable information about their performance. Moreover, a number of well-publicized shenanigans drove the lesson home that even the most savvy investors could get taken. In one of the most famous incidents, Cornelius Vanderbilt's attempt to buy control of the Erie Railroad was frustrated by a clever subterfuge that allowed the Erie's treasurer, Daniel Drew, to print a seemingly endless amount of new stock.³¹

The information problems that plagued the securities markets were a source of opportunity for entrepreneurs who could elicit the trust of investors. During the depression of the 1890s, for example, members of the New York Stock Exchange

²⁸ Larry Neal, 1971, "Trust Companies and Financial Innovation, 1897-1914," *Business History Review*, 45 (Spring): 35-51.

²⁹ John A. James, 1976, "The Development of the National Money Market, 1893-1911," *Journal of Economic History*, 36 (Dec.): 878-97.

³⁰ Eugene Nelson White, 1982, "The Political Economy of Banking Regulation, 1864-1933," *Journal of Economic History*, 42 (March): 33-40.

³¹ Charles F. Adams, Jr., 1869, "A Chapter of Erie," *North American Review*, 109 (July): 30-106. More generally, see Jonathan Barron Baskin and Paul J. Miranti, Jr., 1997, *A History of Corporate Finance* (New York: Cambridge University Press).

(NYSE) responded to the declining profitability of their brokerage businesses by instituting important rule changes, most notably requiring firms whose securities traded on the exchange to file annual reports. The new rules made listing on the NYSE an imprimatur of quality, and not surprisingly, paid off in a dramatic rise in the price of a seat on the exchange.³² To give another example, the private banker J. P. Morgan assiduously cultivated a reputation for financial probity and fair dealing, which he was able to exploit to create a market for railroad stock when he reorganized a number of bankrupt railroads during the 1890s. Morgan's method in the early stages of a reorganization was to establish a voting trust for investors' stock that would be under his personal control and give him the power to monitor and shape the railroad's business practices. When the trust expired at the end of some agreed-upon period, Morgan continued to protect investors' interests by keeping one of his partners on the railroad's board. During the Great Merger Movement, he played a similar role when he promoted important consolidations such as the United States Steel Corporation. Shareholders in "Morganized" firms generally earned above market returns on their investments.³³

The investments in reputation that men like Morgan and the brokers on the NYSE made seem to have reassured investors who proceeded to sink increasing amounts of their savings into equities. The value of new corporate shares issued on the New York Stock Exchange rose rapidly. Even before the speculative bubble of the 1920s it reached levels relative to GDP that were higher than those attained in the second half of the twentieth

³² Larry Neal and Lance E. Davis, 2007, "Why Did Finance Capitalism and the Second Industrial Revolution Arise in the 1890s?" in *Financing Innovation in the United States, 1870 to the Present*, ed. Naomi R. Lamoreaux and Kenneth L. Sokoloff (Cambridge: MIT Press), pp. 129-61.

³³ Vincent P. Carosso, 1987, *The Morgans: Private International Bankers, 1854-1913* (Cambridge: Harvard University Press); J. Bradford De Long, 1991, "Did J. P. Morgan's Men Add Value? An Economist's Perspective on Financial Capitalism," in *Inside the Business Enterprise: Historical Perspectives on the Use of Information*, ed. Peter Temin (Chicago: University of Chicago Press), pp. 205-36.

century when investors' interests were protected by the Securities and Exchange Commission.³⁴ In the rough and tumble economy of the late-nineteenth-century U.S., risks were high and even the most savvy investors could lose a lot of money. But returns were also high, and intermediaries who were able to elicit investors' trust could earn extraordinary profits.

4. Incentives to Innovate: The Dissemination of Technological Information

People are more likely to invest time and resources in inventing new technologies if they think they will be able to profit from their discoveries.³⁵ They can only profit from their discoveries, however, if they can prevent competitors from stealing them. One important way to do this is to keep their ideas secret. Although this strategy can be a profitable one for inventors, it may harm society by inhibiting the dissemination of technological information. Moreover, it may even be suboptimal from the standpoint of individual inventors. In the first place, it may prevent them from acquiring knowledge that could help them surmount technological hurdles more efficiently or devise solutions to problems that otherwise seemed intractable. In the second, it may prevent them from profiting from their inventions in other ways—for example, by selling their them to other individuals or firms better placed to exploit them commercially. Once inventors can extract returns from their ideas by selling them off, they can benefit from a division of labor that allows them to specialize in the creative work they do best.³⁶

³⁴ Mary O'Sullivan, 2004 "What Drove the US Stock Market in the Last Century?" unpublished paper.

³⁵ Jacob Schmookler, 1966, *Invention and Economic Growth* (Cambridge: Harvard University); Sokoloff, 1988, "Inventive Activity in Early Industrial America."

³⁶ Naomi R. Lamoreaux and Kenneth L. Sokoloff, 2003, "Intermediaries in the U.S. Market for Technology, 1870-1920," in *Finance, Intermediaries, and Economic Development*, ed. Stanley L.

Patents, of course, provided inventors with an alternative way of protecting their ideas from theft. The U.S. patent system, as discussed in the last chapter, inventors enforced intellectual property rights at quite a modest cost. As a result, patentees were able to exchange technological information with each other and with potential buyers for their inventions with comparatively little fear that their ideas would be stolen. Moreover, the U.S. Patent Office actively encouraged the dissemination of technological information by offering researchers free and open access to the specifications and models stored in its Washington headquarters, by publishing lists of inventions that obtained patents, and by buying advertisements in private journals that reported information about patents. The most famous of these journals, *Scientific American*, printed lists of patents granted on a weekly basis, featured lengthy descriptions of the most important new technologies, and offered to send its readers copies of complete patent specifications for a small fee. Over time, more specialized trade journals emerged to keep producers informed about patents in particular industries. For example, the *Journal of the Society of Glass Technology* provided detailed descriptions of all patents taken out in the United States and Britain relating to the manufacture of glass.³⁷

Of course, in order to take advantage of this flood of information inventors had to be literate and numerate and have enough basic technological and scientific knowledge to

Engerman, Philip T. Hoffman, Jean-Laurent Rosenthal, and Kenneth L. Sokoloff (New York: Cambridge University Press), pp. 209-46; and Lamoreaux and Sokoloff, 2007, "The Market for Technology and the Organization of Invention in U.S. History," in *Entrepreneurship, Innovation, and the Growth Mechanism of the Free-Enterprise Economies*, ed. Eytan Sheshinski, Robert J. Strom, and William J. Baumol (Princeton: Princeton University Press), pp. 213-43. Under special circumstances information may be shared in the absence of patent protection. See, for example, Robert Allen, 1983, "Collective Invention," *Journal of Economic Behavior and Organization*, 4 (Jan.): 1-24.

³⁷ Michael Borut, 1977, "The *Scientific American* in Nineteenth Century America," unpublished Ph.D. dissertation, New York University; Naomi R. Lamoreaux and Kenneth L. Sokoloff, 1999, "Inventors, Firms, and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries," in *Learning By Doing in Firms, Markets, and Countries*, ed. Lamoreaux, Daniel M. G. Raff, and Peter Temin (Chicago: University of Chicago Press), pp. 19-57; and Lamoreaux and Sokoloff, "Market for Technology."

translate the words and diagrams on the page into working devices. During the first half of the nineteenth century, when most cutting-edge technologies were mechanical in character, the requisite knowledge was relatively easy to obtain. Basic schooling was widely available at low cost, with the result that most adults had the reading and math skills they needed to learn about new technological developments.³⁸ At the same time, traditional apprenticeships and other ways of acquiring on-the-job training provided practitioners with sufficient technical skills to be able to push out the frontiers of knowledge.³⁹ During the second half of the century, however, science-based technologies would become more important, and new institutions for transmitting and disseminating knowledge would be needed. The land-grant colleges founded after the Morrill Act were an important source of the requisite training. But much of the growth in higher education during the late nineteenth century was funded by private sources, including businesses seeking to create local pools of expertise to meet their needs. The result was an extensive but decentralized system of colleges and universities in which research was often oriented toward the concerns of local industries (tires in Akron, for example, and mining in Minneapolis) and which gave a larger proportion of the population access to advanced training than anywhere else in the world at that time.⁴⁰

³⁸ Ellwood P. Cubberley, 1920, *The History of Education: Educational Practice and Progress Considered as a Phase of the Development and Spread of Western Civilization* (New York: Houghton Mifflin); Lawrence A. Cremin, 1980, *American Education: The National Experience, 1783-1876* (New York: Harper & Row); Carl F. Kaestle, 1983, *Pillars of the Republic: Common Schools and American Society, 1780-1860* (New York: Hill and Wang).

³⁹ For an excellent example, see Jacob Dolson Cox, Sr., 1951, *Building an American Industry: The Story of the Cleveland Twist Drill Company and Its Founder* (Cleveland: Cleveland Twist Drill Co.). More generally, see Edward W. Stevens, Jr., 1995, *The Grammar of the Machine: Technical Literacy and Early Industrial Expansion in the United States* (New Haven: Yale University Press).

⁴⁰ Richard R. Nelson and Gavin Wright, 1992, "The Rise and Fall of American Technological Leadership: The Postwar Era in Historical Perspective," *Journal of Economic Literature*, 30 (Dec.): 1931-64; David F. Noble, 1977, *America By Design: Science, Technology, and the Rise of Corporate Capitalism* (New York: Oxford University Press); Roger L. Geiger, 1986, *To Advance Knowledge: The Growth of American Research Universities, 1900-1940* (New York: Oxford University Press), pp. 1-57; David C.

4.1. Parsing the Flood of Information

The tremendous flood of information about new technologies posed a daunting problem to business people who wanted to invest in promising discoveries. How could they assess the merits of the thousands of inventions patented each year? How could they distinguish inventions that were unlikely to work or would never be economical from those that had the potential to earn significant profits? Unless there was some way of separating important inventions from the mass of patented ideas, the former were unlikely to be put to productive use.

One simple solution was for investors to tap into the discussions that inventors themselves were having about new technologies. During the late nineteenth century certain kinds of enterprises were especially likely to become focal points for such conversations. For example, hardware stores were gathering places for people who made and bought the vast variety of gadgets they sold and hence were good places to obtain information about new products and production processes.⁴¹ Telegraph firms were also magnets for technologically creative people. Early telegraph offices were stocked with books and journals about electrical technology because operators were responsible for maintaining the equipment as well as for sending and receiving messages. Many of the operators who learned about telegraph technology on the job devised ways to improve it. Thomas Edison is only the most famous example of an inventor who got his start in this way. Western Union executives paid attention to what their employees were doing and often provided them with the financial support they needed to commercialize their

Mowery and Nathan Rosenberg, 1989, *Technology and the Pursuit of Economic Growth* (New York: Cambridge University Press), pp. 92-95.

⁴¹ Naomi R. Lamoreaux, Margaret Levenstein, and Kenneth L. Sokoloff, 2006, "Mobilizing Venture Capital During the Second Industrial Revolution: Cleveland, Ohio, 1870-1920," *Capitalism and Society*, 1, issue 3, article 5, <http://www.bepress.com/cas/vol1/iss3/art5/>.

discoveries. At the same time, financiers used their telegraph-company connections to learn about promising new technologies. J. P. Morgan investments in Edison's incandescent lighting project came about, for example, because two of his partners were friendly with Western Union's patent attorney.⁴²

Important firms in the new industries of the period could also become the hubs of overlapping networks of inventors and financiers. A good example was the Brush Electric Company, the pioneer arc lighting firm established in Cleveland in 1880. The inventors' network that formed around the Brush enterprise included employees who obtained valuable technical training in the course of their work, learned about opportunities for spinoff enterprises, and used the contacts their position afforded them to launch their own companies. It also included creative individuals who were not Brush employees but who had come there to develop technologies that were complementary to the company's main dynamo and lighting businesses. Sidney Short, for instance, moved to Cleveland and to Brush in order to supervise construction of the custom generators he needed for his electric streetcar invention. He stayed and ran his Short Electric Railway Company out of the Brush factory.

For Short and others like him, the inventors who gathered at the Brush facility provided a useful vetting function. The conversations they had about each other's inventions—which ones were likely to work and which to prove economically valuable—provided the financiers who plugged into these networks with the information they needed to decide where to put their investments. Thus Short was able with Brush's help

⁴² Paul Israel, 1992, *Machine Shop to Industrial Laboratory: Telegraphy and the Changing Context of American Invention, 1830-1920* (Baltimore: Johns Hopkins University Press); Paul Israel, 1998, *Edison: A Life of Invention* (New York: John Wiley & Sons); Stephen B. Adams and Orville B. Butler, 1999, *Manufacturing the Future: A History of Western Electric* (New York: Cambridge University Press).

to find financial backing for his enterprise. Similarly, Alfred and Eugene Cowles benefitted from building their experimental electric aluminum smelting furnace at the Brush factory. Brush had originally scoffed at their ideas, dismissing their smelting process as just an expensive way to burn coal, but after their furnace worked he became a believer and used their aluminum to manufacture his dynamos. The conversion of Brush and other observers at the factory helped the Cowles brothers raise capital, as did their ability to invite potential backers to come see their furnace in operation.⁴³

Another example of a hub enterprise was the Olds Motor Works in Detroit. Founded in 1901, it was the first automaker to locate in Detroit. It was also one of the earliest volume producers in the industry, and by purchasing large quantities of parts from independent suppliers, it created incentives for other firms to set up in Detroit. Although the Olds Motor Works did not survive the decade as an independent firm, it played a key role in the growth of the Detroit automobile industry, serving as a source of both technological ideas and spinoff enterprises, including Cadillac, Ford, and Buick. According to Steven Klepper, employees tend to leave their positions and form new firms when they have ideas that their employers are not able or willing to exploit. Precisely because of their innovative character, however, spin-offs face problems raising capital from investors who have wealth but not technological expertise unless they can rely on people with experience in the industry to convey information about the merits of their projects to potential backers. In addition to employees with new ideas, firms like Olds

⁴³ Naomi R. Lamoreaux, Margaret Levenstein, and Kenneth L. Sokoloff, 2007, "Financing Invention during the Second Industrial Revolution: Cleveland, Ohio, 1870-1920," in *Financing Innovation in the United States, 1870 to the Present*, ed. Lamoreaux and Sokoloff (Cambridge: MIT Press), pp. 39-84; and Lamoreaux, Levenstein, and Sokoloff, "Mobilizing Venture Capital."

spawned networks of experts who were able to mediate between financiers and these innovators.⁴⁴

4.2. Intermediaries in the Market for Technology

A more general solution to the overwhelming flood of information was to rely on expert professionals to assess the merits of inventions offered on the market. The creation in 1836 of the patent examination system, discussed in the previous chapter, had fostered the rise of a cadre of patent agents and lawyers, men who generally had as much or more technical training as they did schooling in law. These professionals could appraise patents for purchasers and evaluate the intellectual property of firms on behalf of potential investors.⁴⁵ Their main business, of course, was to process inventors' applications for patents, and as a result they obtained advance knowledge of technologies that would soon be coming out. Serving both sides of the market in this way, they were in a unique position to match inventors who would have patents to sell with business people likely to be interested in purchasing the rights. They were also in a unique position to find investors for new high-tech enterprises being formed.⁴⁶

⁴⁴ Steven Klepper, 2007, "The Organizing and Financing of Innovative Companies in the Evolution of the U.S. Automobile Industry," in *Financing Innovation in the United States, 1870 to the Present*, eds. Naomi R. Lamoreaux and Kenneth L. Sokoloff (Cambridge: MIT Press), pp. 85-128.

⁴⁵ Lamoreaux and Sokoloff, 2003, "Intermediaries in the U.S. Market for Technology."

⁴⁶ The first patent agents established their offices in Washington, where they could have frequent contact with examiners in the Patent Office. Very quickly, however, others appeared in other parts of the country, especially in areas like southeastern New England where there were already significant numbers of inventors who could make use of their services. Many of these outlying agents developed correspondent relationships with patent solicitors located in Washington and in other major cities. Relationships with agents in Washington allowed those far away to have a representative on the spot who could check records in the Patent Office for relevant prior art and also get first-hand advice from examiners about the sustainability of patent claims. Relationships with agents in other cities gave them access to information about both the supply of and demand for inventions in different parts of the country. Lamoreaux and Sokoloff, 2003, "Intermediaries in the U.S. Market for Technology."

By cultivating relations of trust with individuals on both sides of the market, moreover, patent agents and lawyers were able to reduce the transaction costs that afflicted trade in technology. Inventors often dealt repeatedly with the same patent attorneys, becoming comfortable enough to run ideas by them at an early stage. Buyers also came to trust the judgment of attorneys they employed over and over and therefore required less information to be revealed about the technology than might otherwise have been the case. Of course, because patent attorneys stood to profit from the sale and licensing of patent rights, there was a risk that they would pursue their own interests at the expense of both sellers and buyers of patents. For this reason the most successful practitioners invested in building reputations for fair dealing. Edward Van Winkle, a patent solicitor in New York City in the early twentieth century, devoted the greater part of each day to receiving visitors, calling upon people, and meeting with inventors and businessmen over lunch or dinner. He was able in this way to build an extensive personal network that enabled him to broker numerous agreements between inventors and buyers of their inventions and even organize companies to exploit promising inventions.⁴⁷

5. Incentives to Innovative: Problems of Corporate Governance

In a legal sense, organizing new companies was relatively easy. As noted in the previous chapter, most of the U.S. states had passed general incorporation laws by the middle decades of the nineteenth century. Simply by registering their enterprises and paying a fee, business people could secure the advantages of the corporate form: concentrated management, owner shielding (limited liability), entity shielding (the

⁴⁷ Lamoreaux and Sokoloff, 2003, "Intermediaries in the U.S. Market for Technology."

enterprise's assets could not be seized by creditors of bankrupt members of the firm), and the ability to lock in capital.⁴⁸ Over the course of the late nineteenth and early twentieth centuries, states made the reporting requirements associated with organizing a corporation less burdensome and also put fewer restrictions on what corporations were able to do. New Jersey passed an especially liberal general incorporation law in 1888 that made it possible for corporations to hold stock in other corporations. In other states large-scale businesses were forced to resort to subterfuges such as the trust form of organization in order to merge their enterprises, and so they increasingly shifted to New Jersey charters instead. Some of the states that lost chartering revenues responded by adopting similar statutes or by passing even more liberal laws. Delaware ultimately won this chartermongering competition.⁴⁹

The difficult task was not organizing a high-tech enterprise as a corporation, but inducing wealthy business people to purchase equity stakes. Adding to the problem of technological uncertainty was the lack of protection for minority investors during this period. Controlling shareholders could extract more than their fair share of the enterprise's profits in a variety of ways that included electing themselves to lucrative

⁴⁸ Ernst Freund, 1896, "The Legal Nature of the Corporation," Ph.D. dissertation, Columbia University; Henry Hansmann and Reinier Kraakman, 2000, "The Essential Role of Organizational Law," *Yale Law Journal*, 110 (Nov.): 387-440; Margaret M. Blair, 2003, "Locking in Capital: What Corporate Law Achieved for Business Organizers in the 19th Century," *UCLA Law Review*, 51 (Dec.): 87-455. By limited liability I mean a ceiling on shareholders' potential losses from a bankruptcy. Shareholders in specific types of enterprises (such as banks and railroads) were responsible in some states for double or triple the par value of their stock. See Morton J. Horwitz, 1992, *The Transformation of American Law, 1870-1960: The Crisis of Legal Orthodoxy* (New York: Oxford University Press), p. 94.

⁴⁹ Arthur K. Kuhn, 1912, *A Comparative Study of the Law of Corporations with Particular Reference to the Protection of Creditors and Shareholders* (New York: Columbia University); E. Merrick, Dodd, Jr., 1936, "Statutory Developments in Business Corporation Law, 1886-1936," *Harvard Law Review*, 50 (Nov.): 27-59; John W. Cadman, 1949, *The Corporation in New Jersey: Business and Politics, 1791-1875* (Cambridge: Harvard University Press); Christopher Grandy, 1987, "The Economics of Multiple Governments: New Jersey Corporate Chartermongering, 1875-1929," unpublished Ph.D. diss., University of California, Berkeley; William G. Roy, 1997, *Socializing Capital: The Rise of the Large Industrial Corporation in America* (Princeton: Princeton University Press).

corporate offices, contracting on favorable terms with enterprises in which they had an ownership interest, and borrowing corporate funds at below market rates of interest. Minority shareholders who were disadvantaged by such actions could do little to remedy the situation. By definition, they did not have the votes to secure either a change in policy or the dissolution of the corporation. Nor, except in the most egregious cases, could they secure the intervention of the courts.⁵⁰

Nonetheless, the number of new corporations grew rapidly between the Civil War and the 1920s. Indeed, the increase was so steep that an index of incorporations (1925=100) had a value of only about 5 in 1870.⁵¹ So long as investors thought they could earn returns that significantly exceeded those available on government securities and other similar instruments, they did not seem to worry about whether controlling shareholders would extract more than their fair share of the enterprise's returns.⁵² It is possible, moreover, that the private benefits of control that majority shareholders could command actually increased the incentive for entrepreneurs to form new ventures.

Protections for creditors were also weak during this period. Except for brief periods from 1800-1803, 1841-1843, and 1867-1878, there was no federal bankruptcy law until 1898. Most state insolvency laws provided that the assets of a failed debtor would be distributed among creditors on a first-come, first-serve basis, a method of settlement that advantaged those with inside information and invited collusion between

⁵⁰ Naomi R. Lamoreaux and Jean-Laurent Rosenthal, 2006, "Corporate Governance and the Plight of Minority Shareholders in the United States before the Great Depression," in *Corruption and Reform: Lessons from America's Economic History*, ed. Edward L. Glaeser and Claudia Goldin (Chicago: University of Chicago Press), pp. 125-52.

⁵¹ George Heberton Evans, Jr., 1948, *Business Incorporations in the United States, 1800-1943* (New York: National Bureau of Economic Research), p. 34.

⁵² Lamoreaux and Rosenthal, 2006, "Corporate Governance and the Plight of Minority Shareholders"; and Lamoreaux, 2006, "Did Insecure Property Rights Slow Economic Development? Some Lessons from U.S. History," *Journal of Policy History*, 18 (Issue 1): 146-64.

debtors and favored creditors. Many states also discriminated against out-of-state creditors, assigning them lower priority for repayment than in-state creditors.⁵³

Moreover, when these problems were finally solved with the passage of a new federal bankruptcy act in 1898, the law gave debtors much more favorable treatment than was the case in Great Britain or other advanced industrial countries of the time, even allowing them to maintain control of their assets.⁵⁴

Nonetheless, the supply of credit expanded steadily. By 1920 net private debt in the U.S. economy totaled \$105.8 billion, or 121.5 percent of GDP. Earlier figures are not available, but the change in the magnitude of commercial bank loans during the period before 1920 provides an indication of the steepness of the rise. Total commercial bank loans outstanding increased from \$518 million in 1865 (5.5 percent of GDP) to \$28,562 million in 1920 (32.8 percent of GDP).⁵⁵ Here again, it seems, opportunities for profits outweighed the discouragement of weak protection for investors. It is also possible that the lenient environment for debtors encouraged risk taking and hence entrepreneurship.⁵⁶

6. The Effect of Discrimination on the Incentive to Innovate

The incentives that U.S. institutions provided to engage in entrepreneurship were greater for some groups in the population than for others. Married women labored under legal disabilities created by the institution of coverture that were only gradually removed over the course of the nineteenth century. Because their economic identity was subsumed

⁵³ Bradley Hansen, 1998, "Commercial Associations and the Creation of a National Economy: The Demand for Federal Bankruptcy Law," *Business History Review*, 72 (Spring): 86-113.

⁵⁴ David A. Skeel, Jr., 2001, *Debt's Dominion: A History of Bankruptcy Law in America* (Princeton: Princeton University Press).

⁵⁵ Carter et al., 2006, *Historical Statistics*, Vol. 3, pp. 24-25, 650-51, 774

⁵⁶ See Edward J. Balleisen, 2001, *Navigating Failure: Bankruptcy and Commercial Society in Antebellum America* (Chapel Hill: University of North Carolina Press).

under that of their husbands, who had legal control of their property and any income they received, they could not trade on their own account or enter into contracts without their husbands' approval. One might expect these restrictions to have discouraged married women from pursuing entrepreneurial opportunities, and the patent data suggests that this was indeed the case. Taking advantage of variation across states in the pace at which coverture was abolished, B. Zorina Khan found that patenting by women was significantly lower in states where the rules of coverture were still in force and that it increased with the passage of legislation granting property rights to married women.⁵⁷ Even when they were freed from the legal disabilities of coverture, however, women entrepreneurs faced difficulties (for example, in obtaining credit) that put them at a disadvantage relative to men. Not surprisingly, they were most likely to be successful in industries like cosmetics where their understanding of the market and the particular needs of their customers offered counterbalancing advantages.⁵⁸

The situation facing African-Americans was in some respects similar. Although the abolition of slavery and the passage of the Fourteenth Amendment to the Constitution granted African-Americans the full property rights afforded American citizens, the discrimination they faced in practice made all economic ventures, let alone entrepreneurial ones, more uncertain than they would otherwise be. African-Americans were less likely than white Americans of comparable income levels to obtain trade or bank credit, and they were more likely to have the fruits of their labor destroyed or

⁵⁷ B. Zorina Khan, 1996, "Married Women's Property Laws and Female Commercial Activity: Evidence from United States Patent Records, 1790-1895," *Journal of Economic History*, 56 (June): 356-88.

⁵⁸ See, for example, Kathy Peiss, 1998, *Hope in a Jar: The Making of America's Beauty Culture* (New York: Metropolitan Books). More generally, see Angel Kwolek-Folland, 1998, *Incorporating Women: A History of Women and Business in the United States* (New York: Twayne) and Mary Yeager's massive three-volume compilation, 1999, *Women in Business* (Cheltenham, UK: Elgar).

expropriated extra legally. The prospects for African Americans were better in some parts of our period than in others, and one might expect their entrepreneurial activity to have increased in good times and decline in bad. Lisa Cook has argued that patenting by African-Americans did indeed track measures of their political status, but it is difficult to get data on inventive activity by African-Americans that is not itself affected by the extent of discrimination.⁵⁹ In her landmark study of black business, Juliet E. K. Walker calls the first three decades of the twentieth century the “golden age” of African-American entrepreneurship. Black entrepreneurs were particularly successful in the hair care and beauty aids industries and in providing services to members of their communities in sectors such as finance, transportation, and entertainment, where they were not particularly well served by white businesses.⁶⁰

7. Innovation vs. Replication

According to Joseph Schumpeter’s classic model of entrepreneurship, innovation enables an entrepreneur to earn pure economic profits, and those profits in turn attract imitators until they are competed away.⁶¹ There is no question that, as soon as an idea proved profitable, business people in the late-nineteenth-century U.S. raced to copy it. In this dynamic environment, however, replication was often difficult to distinguish from innovation. In the first place, more than one entrepreneur was likely to come up with the same idea around the same time. In the second, followers were often innovators in their

⁵⁹ Linda Cook, “Responses in Technical Change to Property-Rights Uncertainty: Evidence from Patenting Activity Among African Americans, 1821-1919,” unpublished paper, 2003.

⁶⁰ Juliet E. K. Walker, 1998, *The History of Black Business in America: Capitalism, Race, Entrepreneurship* (New York: Twayne).

⁶¹ Joseph A. Schumpeter, 1934, *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*, trans. Redvers Opie (Cambridge: Harvard University Press).

own right. Rather than simply copying an idea, they typically improved on it in significant ways. Indeed, forward-thinking entrepreneurs sought ways to benefit from this future stream of innovation, as well as from their original ideas.

A good example of a successful attempt to do both was the Bessemer Association. Henry Bessemer, a British inventor, was only one of several talented individuals who around the same time figured out how to produce steel by blowing hot air or steam through molten iron. In 1863 Alexander Lyman Holley purchased the U.S. rights to Bessemer's patents on behalf of a partnership consisting of himself, an ironmaster, and a banker. By that time, Bessemer had already secured control of most of the competing processes, and Holley finished the task, negotiating a settlement with another group of Americans who controlled a set of patents still outstanding. The result was the formation of the so-called Bessemer Association, which pooled the two groups' U.S. patents.⁶²

Holley himself was an innovator. He redesigned Bessemer's production process, shrewdly adapting it to the needs of the American railroad market, and then licensed the resulting patents to the Association and, through the Association, to a small number of producers. Virtually all the steel mills built in the U.S. during the 1860s and '70s were designed by Holley and used technology licensed by the Association. The licensees in turn were expected to assign the rights to any improvements they made to the Association. For a time Holley and his fellow Associates offered licenses to any producer who paid a \$5000 membership fee. After 1877, however, they began to limit the number of steel mills they admitted to the pool, using their control over the

⁶² Thomas J. Misa, 1995, *A Nation of Steel: The Making of Modern America, 1865-1925* (Baltimore: Johns Hopkins University Press), pp. 19-20.

technology to prevent competition from eroding their returns.⁶³ Although few technology-sharing agreements were as successful as the Bessemer Association, firms that licensed valuable patents to other enterprises often included similar clauses in their contracts giving them rights to subsequent improvements.

In other cases, the patent system itself encouraged what might be called innovative replication. Unless they could buy or license the rights, entrepreneurs who learned the details of an innovation by reading patent specifications and/or reverse engineering a product could only make use of the information they obtained if they could “invent around” it—that is, discover an alternative means to the same end. These efforts often yielded superior results. In electricity, for example, Charles F. Brush, inventor of the pioneer system of arc lighting, protected the various elements of his system with patents. Elihu Thomson knew Brush’s system well. Indeed, he had been the judge of a competition at the Franklin Institute that had awarded Brush the prize for the best dynamo. Within a few years of the contest, however, Thomson had developed his own patented system of arc lighting that improved upon Brush’s in significant ways. Within a decade his company had bought out his predecessor’s.⁶⁴

Although competition among firms led to innovative replication, within a single firm was there significant risk that replication would not be accompanied by additional innovation. Entrepreneurs often become enamored of their own ideas and, though they typically subject them to continual improvement, there is a tendency for the changes to

⁶³ Misa, 1995, *A Nation of Steel*, pp. 20-21; Peter Temin, 1964, *Iron and Steel in Nineteenth-Century America: An Economic Inquiry* (Cambridge: MIT Press), pp. 133-38; Peter B. Meyer, 2003, “Episodes of Collective Invention,” BLS Working Paper 368 (2003).

⁶⁴ W. Bernard Carlson, 1991, *Innovation as a Social Process: Elihu Thomson and the Rise of General Electric, 1870-1900* (New York: Cambridge University Press).

become incremental and adaptive over time rather than fundamental and disruptive.⁶⁵ Although there are certainly entrepreneurs who are willing to scrap everything when a better idea comes along—Andrew Carnegie was a good example, as was Henry Ford before he built the River Rouge plant—they are relatively rare.⁶⁶ Even as fertile an inventive genius as Thomas Edison was susceptible to this failing. His own electrical lighting system had used direct current, and he was implacably hostile to the new alternating-current systems being developed by George Westinghouse and others. In the competitive economy of the late nineteenth century, however, entrepreneurs wedded to outmoded ideas quickly lost ground to more nimble competitors. In the end, Edison's company was acquired in the General Electric (GE) merger by the Thomson Houston Electric Company, whose lead inventor had responded positively to the a.c. challenge.⁶⁷ Once industries came to be dominated by a small number of very large firms such as GE, the risk that conservatism inside the firm would affect the pace of innovation in the economy as a whole would increase.

8. The Rise of Big Business

The period 1865 to 1920 witnessed a dramatic change in the size distribution of firms in the U.S. economy as large-scale enterprises emerged to dominate large segments of industry. This change would have important consequences for the incentive to

⁶⁵ See Schumpeter, 1934, *Theory of Economic Development* and, 1942, *Capitalism, Socialism, and Democracy*.

⁶⁶ Harold C. Livesay, 1975, *Andrew Carnegie and the Rise of Big Business* (Boston: Little, Brown and Co.); David A. Hounshell, 1984, *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States* (Baltimore: Johns Hopkins University Press), pp. 217-61.

⁶⁷ Harold C. Passer, 1953, *The Electrical Manufacturers, 1875-1900* (Cambridge: Harvard University Press), pp. 164-75.

innovative, as well as for the way in which innovation was organized. Those consequences, however, would for the most part not be felt until later in the twentieth century and hence will be left for the next chapter. Here the focus will be on the creation of these large-scale organizations, for they themselves were entrepreneurial responses to the conditions and opportunities of the period.

8.1. The Railroad

As Alfred D. Chandler, Jr., has argued, the railroads were the nation's first big businesses.⁶⁸ They were the first private enterprises to raise substantial sums of money from the capital markets in New York and abroad, and through their seemingly insatiable demand for funds, stimulated the development of new types of financial intermediaries and instruments that would be important for the economy's subsequent growth. As a result of this influx of capital, the railroads grew so large relative to most other businesses at the time that they raised fears about the concentration of economic and political power. Hence the railroads were also the first businesses to provoke a clamor for government regulation—initially at the state level and later at the federal level. Congress's passage of the Interstate Commerce Act in 1887 marked the start of an expanded role for the federal government in regulating the economy.

According to Chandler, the railroads were the first businesses to confront coordination problems that were sufficiently complex to induce them to innovate organizationally. By the 1850s, executives such as Daniel C. McCallum of the New York and Erie, Benjamin Latrobe of the Baltimore & Ohio, and J. Edgar Thomson of the

⁶⁸ See Chandler, 1977, *The Visible Hand*, pp. 81-121.

Pennsylvania Railroad, had realized that it was imperative for both profit and safety to improve control of the rapidly increasing volume of traffic that was flowing over their lines. Over the next several decades they devised organizational charts and manuals that arrayed employees according to a hierarchy of responsibility, clearly specifying the duties of each. They also developed new accounting techniques that enabled them to measure the performance of all the operating units in their dominions.⁶⁹

The managers who staffed these organizations increasingly thought of themselves as professionals. In the post-Civil War period they flocked into national associations such as the American Society of Railroad Superintendents, subscribed to trade publications such as the *Railroad and Engineering Journal*, presented papers at professional meetings on technical details involving railroad administration, and met with their colleagues to discuss and resolve common problems. Collectively they worked to standardize gauges and railroad equipment so as to facilitate the movement of traffic from road to road. They developed system-wide tracking methods that insured each company would be properly credited for the services it provided. They also agreed on a basic structure of freight charges, classifying hundreds of different types of goods into four basic categories.⁷⁰

This cooperative ethic spilled over into the arena of technology. In the industry's early years, railroad managers had fostered technological creativity among their employees and encouraged inventors to bring them new devices. The railroads of this era were rarely in direct competition with each other, and managers had freely shared information about new technological developments. These exchanges of information did

⁶⁹ Chandler, 1977, *The Visible Hand*, pp. 81-121.

⁷⁰ Chandler, 1977, *The Visible Hand*, pp. 122-44.

not stop when railroads' system building made them into rivals. Rather, they became part and parcel of the drive to reduce transshipment costs by standardizing practice across the entire industry. Moreover, as the railroads faced increasing numbers of infringement suits from outside owners of intellectual property in the 1870s, their managers formalized these exchanges by organizing patent pools that could bargain on behalf of all the railroads simultaneously. The pools not only economized on litigation costs but reduced inventors' ability to play one railroad off against another.⁷¹

This move toward more formal patent pools coincided with an internal shift in railroad managers' attitudes toward innovation by employees. Their previous stance of encouragement gave way to a more conservative effort to control the pace and direction of technological change. Because it was critical to be able to couple cars owned by one railroad to all of the company's rolling stock, as well as to that of other companies with interconnecting tracks, a change in one part of the system could wreak havoc to the functioning of the whole. Hence, at the same time as they cooperated to exploit more fully technologies that were already in place, railroad executives increasingly worked to channel and even contain the innovations of their subordinates. Productivity increased at a rapid pace, but innovation became more incremental and adaptive in character.⁷²

⁷¹ Steven W. Usselman, 1991, "Patents Purloined: Railroads, Inventors, and the Diffusion of Innovation in 19th-Century America," *Technology and Culture*, 32 (Oct.): 1047-75, and 2002, *Regulating Railroad Innovation: Business, Technology, and Politics in America, 1840-1920* (New York: Cambridge University Press).

⁷² Usselman, 2002, *Regulating Railroad Innovation*; Albert Fishlow, 1966, "Productivity and Technological Change in the Railroad Sector, 1840-1910," in *Output, Employment and Productivity in the United States after 1800*, Conference on Research in Income and Wealth (New York: National Bureau of Economic Research).

8.2. New Opportunities from the Integration of Production and Distribution

The expansion of the railroad network linked the far-flung regions of the United States into a national market, making it possible for firms in industries characterized by economies of scale to lower their unit costs by concentrating production in large facilities. In such industries the average size of the production unit rose over time and the number of firms declined. At the same time, the level of geographic specialization in the U.S. economy increased.⁷³

The comparatively rapid speed at which railroads operated also created opportunities for entrepreneurs to found new kinds of business. Before the 1870s, for example, cattle were usually shipped live on railroad cars to eastern cities where they were slaughtered for local consumption. Gustavus Swift, an East Coast butcher who had migrated west to become a cattle dealer in Chicago, realized that he could reap enormous cost savings if he could slaughter cattle in the Midwest and ship the beef to eastern markets in refrigerated cars. Packing meat in Chicago would enable him to capture economies of scale and would obviate having to feed and water cattle in transit. He could avoid paying freight on the inedible parts of the animal (more than half the weight of the carcass) and could escape losses from animals losing weight and even dying on route to markets.⁷⁴

Swift faced a lot of opposition to his plan—not only from butchers and wholesalers whose business he threatened, but also from the railroads, who already had

⁷³ Chandler, 1977, *Visible Hand*; Naomi R. Lamoreaux, 1985, *The Great Merger Movement in American Business, 1895-1904* (New York: Cambridge University Press); and Kim, 1995, “Expansion of Markets.”

⁷⁴ On Swift’s innovation and the development of the meatpacking industry, see Mary Yeager, 1981, *Competition and Regulation: The Development of Oligopoly in the Meat Packing Industry* (Greenwich, Conn.: Jai Press); and Chandler, 1977, *Visible Hand*.

extensive investments in cattle cars and feeding stations. As a result, he was forced to build his entire distribution system from scratch. He sunk all the capital he could raise into the construction of a small fleet of cars, managed to get one railroad to carry them, and plunged into the business. His initial successes gave him the wherewithal to expand into sales. He quickly built a network of wholesale facilities with refrigerated storage space and a sales staff to market the meat to local stores. In addition, by buying rights to harvest ice from the Great Lakes and setting up ice houses along his routes, he protected himself against costly bottlenecks that could have damaged both his product and his business. As a consequence of his skill in system building, Swift's enterprise grew rapidly. Swift made his first shipments of dressed beef in 1877. By 1881 he owned nearly 200 refrigerator cars and shipped something on the order of 3,000 carcasses per week.

Swift's creation of a vertically integrated empire changed the nature of competition in the industry. Before Swift built his system, the meatpacking industry had consisted of hundreds of small local slaughterhouses. Afterwards, the only firms that could meet his low prices were the few that could muster the financial resources to copy his strategy and build their own networks of refrigerated cars, ice houses, and distribution outlets. The industry quickly acquired an oligopolistic structure. By 1888 Swift, and the three firms that built similar systems (Armour, Morris, and Hammond) together accounted for about two-thirds of the nation's supply of dressed beef.

Wholesalers handled distribution for most manufacturing industries during the last third of the nineteenth century, but in some instances they were unable (or, as Swift found, unwilling) to do an adequate job. The problem was particularly likely to arise for

technologically complex products such as sewing machines or mechanical reapers. Consumers hesitated to buy these products unless they were taught how to use them and assured that broken machines would be swiftly and cheaply repaired. Independent wholesalers lacked the expertise and incentive to provide such instructional and repair services, so manufacturers had to provide them themselves. Entrepreneurial firms that took the lead in offering such services, such as Singer in sewing machines and McCormick in reapers, rapidly grabbed major shares of the domestic market. The tremendous amount of capital needed for copy their distribution systems kept the number of competitors small, and just as in the case of meatpacking, these industries acquired oligopolistic structures.⁷⁵

8.3. The Standard Oil Trust

The railroad industry itself had an oligopolistic market structure. Because railroads had enormous sunk costs, wherever multiple railroads served a particular region, they competed vigorously for freight. The railroads attempted to put limits on this competition by forming themselves into cartels, but these efforts were rarely successful, especially before the 1880s.⁷⁶ Nonetheless, one particularly entrepreneurial producer was able to take advantage of the railroads' eagerness to fix prices to consolidate his own industry. That entrepreneur was John D. Rockefeller.

⁷⁵ Chandler, 1977, *Visible Hand*; Hounshell, 1984, *From the American System to Mass Production*.

⁷⁶ Some scholars have argued that after the railroads formed the Joint Economic Committee in 1879, they were much more successful in preventing ruinous price cuts. See Thomas S. Ulen, 1980, "The Market for Regulation: The ICC from 1887 to 1920," *American Economic Review*, 70 (May), pp. 306-10; Robert H. Porter, 1983, "A Study of Cartel Stability: The Joint Executive Committee, 1880-1886," *Bell Journal of Economics*, 14 (Autumn), pp. 301-14; and John J. Binder, 1988, "The Sherman Antitrust Act and the Railroad Cartels," *Journal of Law and Economics*, 31 (Oct.), pp. 443-68.

During the late 1860s Rockefeller's Standard Oil refinery was the largest in the petroleum industry, but it accounted for only about 4 percent of total industry capacity and did not have any particular advantage in costs. Price competition was eroding profits, and the refiners' repeated attempts to put a stop to it by organizing cartels just as repeatedly failed. In the early 1870s, however, the railroads that served the country's main refining regions collectively offered Standard and other important firms in the industry a deal. The railroads had negotiated an agreement to prevent price cutting in this segment of their business, and they needed the leading refineries to police it. They offered to form them into an association called the South Improvement Company with the task of monitoring oil shipments to make sure that no railroad undercut the agreed upon prices. In return, the refineries would receive a rebate on their own shipments and also a drawback on their competitors' shipments.⁷⁷

Although the South Improvement agreement was never implemented,⁷⁸ there was a several month period (after the company was formed but before it fell apart) when prospects seemed dim for refineries not included in the scheme. Rockefeller took advantage of the situation to induce the other firms to sell out. As Elizabeth Granitz and Benjamin Klein have demonstrated, only fear of the effects of the agreement on their competitive position can explain why so many non-members sold their refineries to Rockefeller during these months, many of them at distress prices.⁷⁹ Emerging from this episode with effective control of the Cleveland segment of the industry, Standard then

⁷⁷ Elizabeth Granitz and Benjamin Klein, 1996, "Monopolization by 'Raising Rivals' Costs': The Standard Oil Case," *Journal of Law and Economics*, 39 (April): 1-47.

⁷⁸ The plan collapsed in the face of determined opposition from producers in the oil fields who threatened to enforce an embargo on shipments to the South Improvement Company with violence. See Granitz and Klein, 1996, "Monopolization by 'Raising Rivals' Costs.'"

⁷⁹ Under normal conditions, given the petroleum industry's cost structure, refiners would not have been worried by the formation of a cartel for as outsiders they would have been able to "free ride" on Standard's high prices. Granitz and Klein, 1996, "Monopolization by 'Raising Rivals' Costs.'"

secretly merged with the original participating refiners in the other production centers. As a result of these acquisitions and mergers, Standard was large enough in and of itself to police the railroads' cartel agreements, and they willingly rewarded it for performing this service with rebates on its shipments. This favored position then allowed Standard to use its ability to "raise rivals' costs" to secure monopoly control of the industry.⁸⁰

8.4 The Great Merger Movement

Most capital intensive industries in the late nineteenth-century were more like petroleum than meatpacking or sewing machines. That is, most manufacturers still distributed their products through independent wholesalers, and the intertwined processes of innovation and replication meant that most firms in an industry used essentially the same or comparable technologies. Although there were exceptional cases where entrepreneurs managed to obtain some kind of significant advantage (the crude-steel industry, which Andrew Carnegie dominated, is a case in point), most capital-intensive industries were populated by a relatively small number of evenly matched firms whose fierce competition for market share often drove prices to unremunerative levels. As in the case of petroleum, firms attempted to negotiate collusive arrangements to limit price cutting but were rarely successful. Like Standard, therefore, they turned to mergers for relief, consolidating most or all of the competing firms into a single large enterprise.⁸¹

The petroleum mergers were followed in the 1880s by a small number of others, most notably in the sugar, lead, whiskey, linseed oil, cotton-seed oil, and cordage industries. Mergers continued at a slow pace in the 1890s and then took off as the

⁸⁰ Granitz and Klein, 1996, "Monopolization by 'Raising Rivals' Costs.'"

⁸¹ Lamoreaux, 1985, *Great Merger Movement*.

economy rebounded from the depression of that decade. Thirteen multi-firm consolidations had been formed during the depression years 1895-97, but in 1898 the number suddenly rose to sixteen and in 1899 to sixty-three. Thereafter the number began to tail off again—to twenty-one in 1900, nineteen in 1901, seventeen in 1902, five in 1903, and three in 1904. All told, between 1895 and 1904 more than 1,800 manufacturing firms disappeared into consolidations, many of which acquired substantial shares (at least initially) of the markets in which they operated. Of the ninety-three consolidations whose market shares it is possible to estimate, seventy-two controlled at least 40 percent of their industries and forty-two at least 70 percent.⁸²

Despite their initially impressive market shares, many of the new consolidations were no more successful over the long run than the collusive agreements they had replaced. The high prices they charged after their formation stimulated an influx of competition, causing virtually all to lose ground and many even to fail. Examining their earnings records for the first third of the twentieth century, Shaw Livermore categorized 37 percent of the mergers as failures, 7 percent as failures that were subsequently rejuvenated, 12 percent as marginal or “limping” concerns, and only 44 percent as successes in the sense that their profit rate at least equaled the average for the manufacturing sector.⁸³

The survivors transformed the business environment in important ways, however. Consolidations were usually financed by the issue of securities, and the profitability of the most successful ones, as well as the new techniques that their promoters (most notably J. P. Morgan) developed to create markets for their stock, paved the way for other

⁸² Lamoreaux, 1985, *Great Merger Movement*, pp. 1-5.

⁸³ Shaw Livermore, 1935, “The Success of Industrial Mergers,” *Quarterly Journal of Economics*, 50 (Nov.): 68-96.

industrial securities to be sold on the national exchanges. As a result of the merger movement, then, large manufacturing corporations gained the same access to national capital markets that the railroads had earlier achieved.⁸⁴

In industries where they proved successful, moreover, consolidations had a major impact on competitive behavior. The merger of virtually all the firms in an industry created a “dominant firm” that could set prices for the remaining fringe of smaller competitors. Consolidations could only maintain this position over time, however, if there were barriers to entry into the industry or if they had advantages that, like Standard Oil’s, that allowed them effectively to raise rivals’ costs. Otherwise, the high prices they imposed would stimulate an influx of new, more efficient competitors, and their market shares would erode until they no longer had the power to set prices for their industries.⁸⁵

According to Chandler, the most successful of the consolidations tended to be those that created barriers to entry by integrating forward into distribution. Certainly, there is no question that, by taking control of distribution, the most entrepreneurial of these enterprises were able to exploit new marketing opportunities. Independent wholesalers had typically sold their wares as homogeneous products or sometimes, where it was necessary to signal differences in quality, under their own private brands. Crackers, for example, had typically been distributed in bulk to retailers who dumped them unbranded into barrels in their stores. After the National Biscuit merger, however, the consolidation began to distribute its product in individual packages under the

⁸⁴ Thomas R. Navin and Marian V. Sears, 1955, “The Rise of a Market for Industrial Securities, 1887-1902,” *Business History Review*, 29 (June): 105-38; Baskin and Miranti, 1997, *History of Corporate Finance*; De Long, 1991, “Did J.P. Morgan’s Men Add Value?”

⁸⁵ Lamoreaux, 1985, *Great Merger Movement*, pp. 118-58.

“Uneeda Biscuit” brand, building its own marketing organization to handle and promote the product.⁸⁶

Once consolidations began to market their own brands, they developed a new concern for protecting them from the encroachments of rival manufacturers. Although brands and trademarks had been a familiar aspect of business activity from time immemorial, protecting these product symbols did not engage the energies of most businessmen until the rise of large-scale organizations at the turn of the century. Not until 1905 did Congress pass a law that protected trademarks in domestic commerce. As Mira Wilkins has argued, the timing of the legislation reflected the new efforts of large firms competing in oligopolistic markets to use product differentiation to preserve and expand their market shares.⁸⁷

8.5. The Reorganization of Technological Discovery

In the intensely competitive environment of the late nineteenth century, firms had to stay on the technological cutting edge in order to survive. They could not afford to be foreclosed from promising new technologies by their rivals' control of critical patents, so they had to keep abreast of developments occurring outside the firm and purchase or license the rights to any that were likely to prove important to their businesses. Although many firms had people on staff (or in ownership positions) who engaged in inventive activity, even the largest enterprises of the time were reluctant to put too much weight on internal R & D. Western Union, for example, sometimes financed the development of

⁸⁶ Chandler, 1977, *Visible Hand*, pp. 331-39.

⁸⁷ Mira Wilkins, 1992, “The Neglected Intangible Asset: The Influence of the Trade Mark on the Rise of the Modern Corporation,” *Business History* 34 (Jan.): 66-95.

new technology in house, but its managers were not convinced that this was the best strategy for staying on the frontier in a time of rapid technological change, and they frequently spun off these enterprises into separate companies.⁸⁸ The position of the American Telephone & Telegraph Company(AT&T) at this time was even more extreme. As T. D. Lockwood, head of the company's patent department, explained: "I am fully convinced that it has never, is not now, and never will pay commercially, to keep an establishment of professional inventors, or of men whose chief business it is to invent."⁸⁹ Instead, AT&T invested in building the capacity to track and assess inventions generated in the external world. Not until Theodore N. Vail became president of the company in 1907 was this policy reversed.⁹⁰ More generally, as David Mowery has argued, an important function of firms' early research facilities was to evaluate outside technologies for possible purchase.⁹¹

The earliest firms to develop in-house R&D laboratories proceeded on a small scale, often for idiosyncratic reasons, until they discovered that the labs brought competitive advantages. During the 1890s, for example, GE faced increasing competition because its basic (Edison) patents on light bulbs had expired, and inventors elsewhere were developing new, more efficient types of filaments. Charles Steinmetz, a consulting engineer at GE's Schenectady factory, had been trained in Germany and

⁸⁸ For example, Western Union financed the consolidation of the innovative partnership of Gray and Barton with its own machine shop, but the resulting enterprise, Western Electric, operated as an independent firm. When Elisha Gray began work on his harmonic telegraph (essentially the telephone), he resigned his position as superintendent of Western Electric but continued to work in its facilities as an independent inventor. Adams and Butler, 1999, *Manufacturing the Future*, pp. 29-38.

⁸⁹ Lockwood did hire inventors from time to time but successfully opposed any sustained investment in in-house R&D. Lockwood is quoted in Lamoreaux and Sokoloff, 1999, "Inventors, Firms, and the Market for Technology," pp. 41-42.

⁹⁰ Louis Galambos, 1992, "Theodore N. Vail and the Role of Innovation in the Modern Bell System," *Business History Review*, 66 (Spring): 95-126.

⁹¹ David Mowery, 1995, "The Boundaries of the U.S. Firm in R&D," in *Coordination and Information: Historical Perspectives on the Organization of Enterprise*, ed. Naomi R. Lamoreaux and Daniel M. G. Raff (Chicago: University of Chicago Press), pp. 147-76.

believed that American firms would do well to emulate the R&D labs that German firms had pioneered. He convinced the company to support a modest research initiative (his budget was \$15,830) to develop an improved incandescent light. Although Steinmetz did not succeed in his mission (GE ultimately had to purchase the technology from German inventors), the experiment nonetheless established the value of having an in-house R&D facility. The lab had provided important services to other parts of the firm by testing materials and resolving technical problems. More importantly, in the process of experimenting with different kinds of filaments, company researchers had filed a number of minor patents which turned out to be useful—not only defensively, by helping the company protect its product line from infringing competitors, but also offensively, as bargaining chips in negotiations with rivals.⁹²

AT&T had a similar experience. Under competitive pressure from new wireless technologies (radio) that threatened its control over local voice communications, it focused its energies on building the capacity to provide long-distance service and set up an in-house laboratory to develop an appropriate amplifier. As was the case at GE, the lab failed in this effort, and AT&T had to purchase Lee de Forest's patents for the triode. But again the research team proved its usefulness. It made possible the successful inauguration of coast-to-coast telephone service in 1915 by solving a number of technical problems with the triode that had to be overcome for it to be commercially practicable. Moreover, the lab's accumulation of "a thousand and one little patents" (in the words of

⁹² W. Bernard Carlson, 1997, "Innovation and the Modern Corporation: From Heroic Invention to Industrial Science," in *Science in the Twentieth Century*, ed. John Krige and Dominique Pestre (Australia: Harwood Academic Publishers, 1997), pp. 203-26; Leonard Reich, 1985, *The Making of American Industrial Research: Science and Business at GE and Bell, 1876-1926* (New York: Cambridge University Press); Reich, 1992, "Lighting the Path to Profit: GE's Control of the Electric Lamp Industry, 1892-1941," *Business History Review*, 66 (Summer): 305-34; George Wise, 1985, *Willis R. Whitney, General Electric, and the Origins of U.S. Industrial Research* (New York: Columbia University Press).

the company's president) kept competitors at bay. Companies like AT&T and GE quickly learned that their labs generated patents that were vital to their rivals' competitive position as well as their own and that by cross-licensing technology to each other they could stabilize their industries and erect barriers to entry.⁹³

Relatively few large companies invested in full blown R&D laboratories before the 1920s.⁹⁴ They had to be convinced that the best strategy for staying on the cutting edge was to develop technology in house. In addition, talented inventors were reluctant to take positions of employment in large firms, and though they might accept jobs at least temporarily, they could not easily be controlled. George Westinghouse learned this lesson when he contracted with William Stanley to develop a transformer. To his chagrin, Stanley claimed that a related discovery he made while working for Westinghouse was his own property.⁹⁵ Less famous inventors could be similarly unreliable, often quitting when they came up with valuable ideas. For example, after two employees of the American Sheet and Tin Plate Company invented a catcher for tinning machines, building the device on company time with company resources and testing it in one of the company's plants, they resigned and contracted with a competitor to develop and commercialize the invention.⁹⁶

⁹³ Carlson, 1997, "Innovation and the Modern Corporation"; Leonard S. Reich, 1977, "Research, Patents, and the Struggle to Control Radio: A Study of Big Business and the Uses of Industrial Research," *Business History Review*, 51 (Summer): 208-35; Reich, 1980, "Industrial Research and the Pursuit of Corporate Security: The Early Years of Bell Labs," *Business History Review*, 54 (Winter): 504-29; Reich, 1985, *Making of American Industrial Research*; Kenneth Lipartito, 2007, "Rethinking the Invention Factory: Bell Laboratories in Perspective," in *The Challenge of Remaining Innovative: Lessons from Twentieth Century American Business*, ed. Sally Clarke, Naomi R. Lamoreaux, and Stephen W. Usselman (Stanford: Stanford University Press, forthcoming).

⁹⁴ Mowery and Rosenberg, 1989, *Technology and the Pursuit of Economic Growth*, pp. 61-65.

⁹⁵ Wise, *Willis R. Whitney*, pp. 70-71.

⁹⁶ Lamoreaux and Sokoloff, 1999, "Inventors, Firms, and the Market for Technology."

Before firms could reap the rewards that might be obtained from internalizing the process of invention, they had to learn to solve a number of important personnel problems. In particular, they had to reduce employee turnover and overcome inventors' resistance to signing over their ideas to their employers. That is, they had to learn how to convince inventors, who had long regarded independent entrepreneurship as the key toward upward mobility, that steady employment offered both rewards and opportunities for advancement. In this endeavor, they would be helped by a rise in the amount of capital required for effective invention, a change that made it more difficult for inventors to maintain their independence. They would also be helped by the growing number of college and engineering-school graduates who not only had the requisite scientific training but were also more amenable to the idea of a career in an organization.⁹⁷

The movement of inventive activity inside large firms made it possible to bring enormous resources to bear on technological problems and to exploit the power of teams of researchers with differing types of expertise. But it also raised the specter of what had happened on the railroads—that the focus of attention would shift toward incremental and adaptive innovation and that more fundamental and disruptive ideas would be discouraged. As the next chapter will show, few large firms were able to avoid this danger, but there were outstanding exceptions. Moreover, as the chapter will also show, the shift in the locus of R&D to large firms' in-house laboratories was never complete.

⁹⁷ Lamoreaux and Sokoloff, 1999, "Inventors, Firms, and the Market for Technology"; and Lamoreaux and Sokoloff, 2007, "The Rise and Decline of the Independent Inventor: A Schumpeterian Story?" in *Challenge of Remaining Innovative*, ed. Clarke, Lamoreaux, and W. Usselman, forthcoming.

Independent inventors and smaller firms would continue to be fertile sources of radical new technological ideas throughout the twentieth century.⁹⁸

9. Government Regulation of the Economy

The federal government's regulatory role in the economy was relatively modest in the decades that followed the Civil War. The National Banking Acts gave the U.S. Comptroller of the Currency responsibility for overseeing banks that held national charters (a declining proportion of the total over time), but there were no other agencies with similar authority over important sectors of the economy. All this would change by the turn of the century. As the states' efforts to respond to popular concerns about the rise of big business ran up against both economic realities and the federal courts, political pressures spurred Congress to increase the federal government's role. The resulting shift in the locus of regulatory authority from the states to the federal government likely had contradictory effects on entrepreneurship, encouraging it in some ways but making it more difficult in others. It did, however, open up new rent-seeking opportunities for businesses in at least some regulated industries.

9.1. Regulation by State and Local Governments

As William Novak has shown, local governments had long routinely intervened in the economy in numerous ways, enforcing standard weights and measures, setting rules for the conduct of trade, requiring licenses to engage in certain kinds of businesses, and

⁹⁸ See also the essays in Clarke, Lamoreaux, and Usselman, ed., *Challenge of Remaining Innovative*, forthcoming.

inspecting the purity or quality of products sold to consumers.⁹⁹ State governments performed a similar range of functions and more. In addition, their authority to charter corporations enabled them to regulate the business of incorporated enterprises in highly specific ways. Although the U.S. Supreme Court ruled in the famous *Dartmouth College* case in 1819 that corporate charters were protected by the contract clause of the Constitution and could not be altered subsequent to issue, states were able to retain their full authority over corporations by including reservation clauses in charters that gave them the right to change the terms in the future. States used corporate charters to limit the amounts of capital that corporations could raise, the types of activities in which they could engage, and their ability to merge with other enterprises. Special types of corporations were subject to additional regulations. Financial institutions, for example, faced restrictions on their ability to open branches, were required to maintain reserves against deposits, and usually had to submit regular reports on their condition.¹⁰⁰

During the late nineteenth and early twentieth centuries state governments expanded their regulatory activities in a number of ways and, in the process, came up against the limits of their authority under the country's federal system of government. For example, state efforts to regulate railroads hit a roadblock when the Supreme Court ruled in *Wabash, St. Louis, and Pacific Railway v. Illinois* in 1886 that a state could not regulate rates on shipments that were part of interstate commerce.¹⁰¹ Similarly, empowered by an interpretation of the Fourteenth Amendment to the Constitution that

⁹⁹ William J. Novak, 1996, *The People's Welfare: Law and Regulation in Nineteenth-Century America* (Chapel Hill: University of North Carolina Press).

¹⁰⁰ Novak, 1996, *People's Welfare*; Charles W. McCurdy, 1979, "The *Knight Sugar* Decision of 1895 and the Modernization of American Corporate Law, 1869-1903," *Business History Review*, 53 (Autumn): 304-42; White, 1983, "Political Economy of Bank Regulation."

¹⁰¹ Herbert Hovenkamp, 1988, "Regulatory Conflict in the Gilded Age: Federalism and the Railroad Problem," *Yale Law Journal*, 97 (May): 1017-72.

enabled the federal courts to strike down regulatory legislation that went beyond what was necessary to protect the public's health or maintain order, the justices in 1905 in *Lochner v. New York* overturned a New York law setting maximum hours of work in bakeries on the grounds that it was an unconstitutional restraint on workers' right to employment. The Court subsequently ruled against a number of other similar statutes.¹⁰²

In the case of large-scale businesses, the states' regulatory efforts were stymied more by economic than political factors. That the power to charter corporations gave states full regulatory authority to proceed against mergers was acknowledged by the federal courts. But this power was not very useful when multi-plant giants could respond to state regulation by securing a charter from a friendlier jurisdiction or even by closing down their enterprises in the state. As a result, after a brief flurry of antitrust activity in the 1880s and the early 1890s, the states largely gave up. If there was going to be an antitrust initiative, it would have to come from the federal government.¹⁰³

9.2. Rise of Federal Regulation

By the late 1880s the popular outcry against railroads and other large-scale businesses had spurred the federal government to act. In 1887 Congress passed the Interstate Commerce Act, creating the Interstate Commerce Commission (ICC) and empowering it make sure that railroad rates were "reasonable and just." Although the bill was confusingly written and the ICC was soon hamstrung by the courts, these problems were subsequently remedied by additional legislation, particularly the Hepburn Act of

¹⁰² Paul Kens, 1998, *Lochner v. New York: Economic Regulation on Trial* (Lawrence: University of Kansas Press).

¹⁰³ McCurdy, 1979, "Knight Sugar Decision"; Lamoreaux, 1985, *Great Merger Movement*, pp. 162-69.

1906 and the Mann-Elkins Act of 1910. Similarly, in 1890 Congress passed the Sherman Antitrust Act prohibiting combinations in restraint of trade or that monopolized their industries. Although the details of the Sherman Act's application were largely worked out in the courts, Congress supplemented the statute by passing the Clayton Antitrust and Federal Trade Commission Acts in 1914. Other regulatory legislation passed by Congress during this period included the Pure Food and Drug Act of 1906, which prohibited the manufacture, sale, or transportation of adulterated or fraudulently labeled foodstuffs and drugs, and the Meat Inspection Act of 1906, which created a federal inspection staff to enforce new sanitary standards in the meat packing industry.¹⁰⁴

The consequences of all this legislation for entrepreneurship have been the subject of much debate. Some scholars have argued that regulators' refusal to grant adequate rate increases effectively destroyed the nation's railroad network by making it difficult for the roads to raise the capital they needed to improve their track and rolling stock. The underinvestment that resulted forced the government to nationalize the railroads during World War I and, in the long run, led to railroads' eclipse by the trucking industry.¹⁰⁵ In Steven Usselman view, however, that the railroad's problems were largely of their own making. Their increasingly rigid focus on exploiting economies of standardization blinded them to changes that were occurring in the transportation sector. Whereas in the late nineteenth century there had been substantial returns to high volume, long-haul operations, in the twentieth century shippers demanded more flexible services over

¹⁰⁴ For an overview of this first major wave of federal regulation, see David Vogel, "The 'New' Social Regulation in Historical and Comparative Perspective," in *Regulation in Perspective: Historical Essays*, ed. Thomas K. McCraw (Cambridge: Harvard University Press, 1981), pp. 155-85.

¹⁰⁵ See especially Albro Martin, 1971, *Enterprise Denied: Origins of the Decline of American Railroads, 1897-1917* (New York: Columbia University Press).

shorter hauls. Trucks triumphed, according to Usselman, because they meet needs that the railroads were unable or unwilling to fulfill.¹⁰⁶

The effects of antitrust law on entrepreneurship were even more ambiguous. In the immediate aftermath of the Sherman Act's passage, prosecutors moved quickly and successfully against cartels and other kinds of collusive arrangements among firms. They found it much more difficult, however, to win convictions against combinations in which competitors had merged to form a single company. Ironically, therefore, the law must be seen as an important cause of the great turn-of-the-century consolidation movement.¹⁰⁷ Similarly, although the courts made certain types of anticompetitive behavior illegal on its face—for example, tying contracts that bound suppliers or customers not to deal with competitors on equal terms—they were rarely willing to proceed against mergers that had much the same consequence. Hence U.S. Steel was able to limit entry into the steel industry by buying up ore reserves, though it would not have been able to negotiate exclusive dealing contracts with ore suppliers. Another problem was that antitrust prosecution depended for its success on complaints from disadvantaged competitors. Such complaints were much more likely to be lodged in industries where large enterprises were competing vigorously than they were where dominant firms enforced price stability. U.S. Steel, for example, was able to insure that competitors would not testify against it in an antitrust suit by guaranteeing that they could operate profitably under its pricing umbrella. It is likely, however, that this guarantee also took away much

¹⁰⁶ Usselman, 2002, *Regulating Railroad Innovation*, pp. 327-80.

¹⁰⁷ Chandler, 1977, *Visible Hand*, 375-76; Tony Freyer, 1995, "Legal Restraints on Economic Coordination: Antitrust in Great Britain and America, 1880-1920," in *Coordination and Information*, ed. Lamoreaux and Raff, pp. 183-203.

of their incentive to innovate.¹⁰⁸ Enforcement of the antitrust laws seems also to have made it more difficult for independent inventors to survive. Because large firms that bought technology on the market were more vulnerable to prosecution than those that developed it in-house, large firms discovered that it was the better part of valor to rely more exclusively on their own laboratories.¹⁰⁹

9.3. New Opportunities for Rent-Seeking

Just as the expansion of the federal government during the Civil War era created opportunities for corruption, the ongoing economic activities of state and local governments encouraged rent-seekers to line their pockets at the public expense. The late nineteenth and early twentieth centuries were the heyday of urban “machine” politics. They were also the years, however, when the quality of urban life improved enormously—when cities built roads, utilities, sewers, water purification facilities, and mass transit systems, improving the health and increasing the prosperity of their populations. As Rebecca Menes has explained, the mobility of the population, in combination with competitive pressures exerted through the ballot box and the bond market, constrained governmental officials, whether corrupt or not, to provide high levels of services. As a result, there is no statistical evidence from this period that corruption was bad for growth. All things being equal, there was little difference in the performance of cities governed by corrupt bosses and those that were not.¹¹⁰

¹⁰⁸ Lamoreaux, 1985, *Great Merger Movement*, 159-86.

¹⁰⁹ Mowery, 1997, “Boundaries of the U.S. Firm in R&D.”

¹¹⁰ Rebecca Menes, 2006, “Limiting the Reach of the Grabbing Hand: Graft and Growth in American Cities, 1880 to 1930,” in *Corruption and Reform*, ed. Glaeser and Goldin, pp. 63-93. See also the essays collected in Bruce M. Stave, ed., 1972, *Urban Bosses, Machines, and Progressive Reformers* (Lexington, MA: Heath).

Corruption, however, was a despised path to wealth during this period. Middle-class Americans associated the rise of machine politics with influxes of impoverished immigrants. Although bosses undoubtedly provided these newcomers with valuable social services in a period when governments were not otherwise meeting their needs, the symbiotic relationship between machines and immigrants increased the ill repute with which both were viewed.¹¹¹ The result was a twin movement to restrict immigration and reform the structure of city governments. Corruption, of course, was never eradicated, but it was rarely the route to high status and social esteem. The heroes of American society were entrepreneurs, not politicians.

The opportunities for rent-seeking that the rise of federal regulation created were probably of greater long-run importance. Here the main beneficiaries, in terms of wealth accumulation, were firms that were able to “capture” the agencies that supposedly oversaw them. Just as the big New York banks had been able to influence the structure of the National Banking System to suit their interests, large-scale enterprises were sometimes able to shape both the content of regulatory legislation and the activities of the agencies entrusted with enforcement. The most important examples of such capture would come later in the twentieth century, however. Although some of the early regulatory initiatives were supported by (and advantaged) large firms, as a general rule they cannot be so easily pigeonholed, and scholars have vigorously debated the extent to which the governmental bodies responsible for their implementation were captured.¹¹²

¹¹¹ Robert K. Merton, 1972, “The Latent Functions of the Machine,” in *Urban Bosses, Machines, and Progressive Reformers*, ed. Bruce M. Stave (Lexington, MA: Heath), pp. 27-37.

¹¹² Contrast, for example, Gabriel Kolko, 1965, *Railroads and Regulation, 1877-1916* (Princeton: Princeton University Press) and Martin, 1971, *Enterprise Denied*. For a complex view of the forces at play in regulation during this period, see Marc T. Law and Gary D. Libecap, 2004, “The Determinants of Progressive Era Reform: The Pure Food and Drugs Act of 1906,” in *Corruption and Reform*, ed. Glaeser and Goldin, pp. 319-42.

10. Conclusion

Americans have always admired entrepreneurs, but during the years 1865-1920 this attitude was more intense than at virtually any other time in U.S. history. This was the period when the expansion of the railroad network and the incorporation of western lands and resources into the national economy created enormous opportunities for profit, and Americans responded with avidity. Farmers moved out onto the new western lands opened for settlement, prospectors searched for gold or other valuable minerals, inventors patented thousands of new technological ideas, business people embodied these ideas in startups and expanded the scope of existing enterprises, and financiers found new ways to meet businesses' growing demand for funds. Although some entrepreneurs accumulated enormous fortunes, in most cases the gains were more modest. Nonetheless, the significant upward mobility that many were able to achieve during this period was an ongoing spur to entrepreneurship.

For most of this period government's role in the economy, especially at the federal level, was mainly promotional in character. The national government made western lands and resources available to those who wanted to exploit them, subsidized transportation, mapped the location of raw material resources, and financed educational and other institutions to supply technological know-how. The U.S. patent system provided strong protection to holders of intellectual property at modest cost and helped to disseminate information about new technologies. The creation of the National Banking System had some unfortunate consequences that increased economic instability, but the system did succeed in instituting a uniform national currency that reduced transactions costs in interregional trade. Moreover, its problems were largely remedied by the

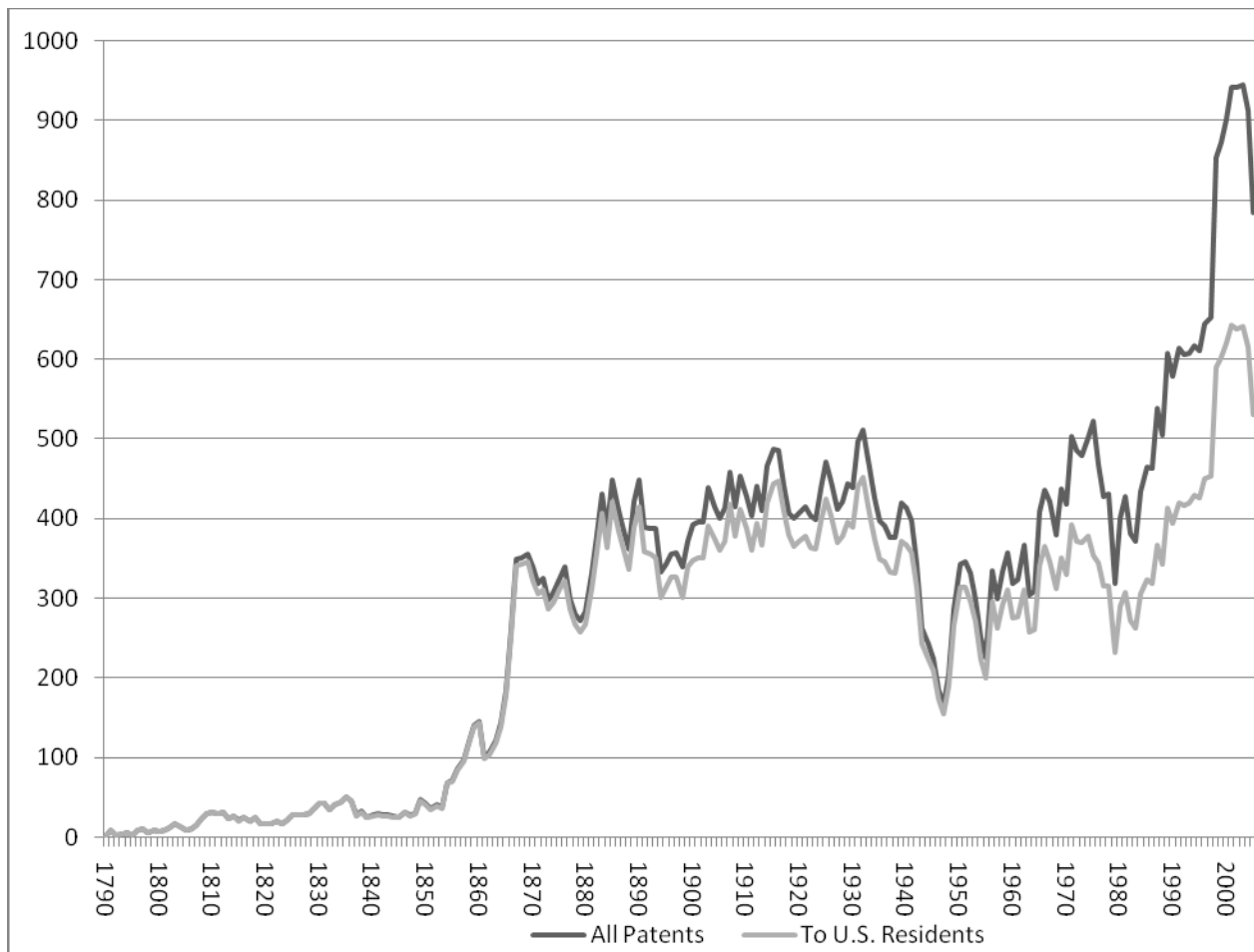
passage of the Federal Reserve Act in 1913. State and local governments played a more active regulatory role in the economy, but even at those levels governments mainly intervened in ways that increased the security and transparency of economic transactions, for example by enforcing standard weights and measures and setting rules for the conduct of trade. Only with the rise of big business would governments take on more significant regulatory functions—first at the state level and then the federal.

Although the institutions that Americans inherited from the era of the nation's founding provided a basic security of property rights, protections for external investors in business enterprises did not meet the standards that policy makers today think are necessary for successful economic development. Minority shareholders in corporations had little recourse against exploitation by controlling shareholders, and insolvency and bankruptcy laws disadvantaged creditors. Although these weaknesses may have made it more difficult for businesses to secure equity investments or loans, there was nonetheless an enormous expansion in the number of corporations and in the levels of equity and debt finance relative to the size of the economy. It seems that the opportunities for profit were sufficiently great that those with savings to invest were willing to take the bear the risk that the lower levels of protection entailed. Moreover, entrepreneurs like J. P. Morgan made investments in reputation that elicited investors' trust. Indeed, throughout the economy, whenever information problems made otherwise remunerative transactions difficult, private agents found it worth their while to develop solutions. Thus patent attorneys used the contacts they assiduously cultivated on both sides of the market for technology to match sellers and buyers of inventions and reduce the amount of information they had to reveal to each other. Similarly, businesses like Singer were able

to induce consumers to purchase complex and expensive durable goods by investing in local distribution outlets that provided instruction and repair services.

A byproduct of this entrepreneurial pursuit of opportunity was the emergence of large-scale businesses with significant market power. Sometimes this market power was a side effect of business decisions made for other reasons—Singer’s investments in distribution, for example, helped to make it the dominant producer in the U.S.—but sometimes, as in the case of Standard Oil, it was deliberately sought. Regardless, the resulting change in the size distribution of firms had enormous consequences. In the first place, it stimulated the state and then the federal government to take on a broader regulatory role in the economy. In the second, it shifted the locus of innovation as large firms built their own in-house R&D laboratories and relied increasingly on internally generated technology rather than buying inventions on the market. How these changes would play out—whether they would be conducive to entrepreneurship or dampen the innovative character of the economy—would not be apparent until much later in the twentieth century. The troubles that the railroad, the first big business, experienced as early as World War I were an important indication that the outcome would not be completely positive. Even in that case, however, the rise of trucking suggested that, in a dynamic economy such as that of the United States, problems in one industry just create opportunities for entrepreneurs in another.

Figure 1. Patents Granted by the U.S. Patent Office per Million Residents of the United States



Sources: Susan B. Carter, et al., 2006, *Historical Statistics of the United States*, Vol. 1, pp. 28-29, Vol. 3, pp. 426-28; U.S. Patent Office, "U.S. Patent Activity: Calendar Years 1790 to the Present," <http://www.uspto.gov/web/offices/ac/ido/oeip/taf/tafp.html>; U.S. Census Bureau, "Population Estimates, 2000-2006," http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=01000US&-_box_head_nbr=GCT-T1&-ds_name=PEP_2006_EST&-lang=en&-format=US-9&-sse=on.