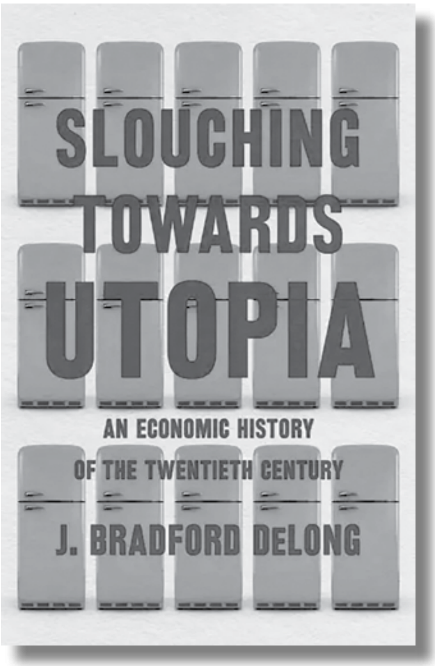
The Meaning *of* 1870

The year everything changed.



An excerpt from **Slouching Towards Utopia: An Economic History of the Twentieth Century** *by J. Bradford DeLong (Basic Books, 2022).*

Before 1870, inventions and innovations had by and large been singular discoveries and adaptations. They produced new and better ways of doing old things: of making thread, of weaving cloth, of carrying goods about, of making iron, of raising coal, and of growing wheat and rice and corn. Having pioneered these improvements, their inventors then set about finding ways to exploit them. It was a process that required inventors to be not just researchers but development engineers, maintenance technicians, human resource managers, bosses, cheerleaders, marketers, impresarios, and financiers as well.

That pre-1870 system was good enough as long as the confluence of circumstances was just right. Consider the invention of the steam engine in the eighteenth century. It needed a cheap source of fuel, it needed something important and profitable to do, and it needed societal competence at the metalworking technological frontier. Fuel was found at the bottom of the coal mines. With the steam engine, cheap, plantation-grown cotton, ideally suited for machine spinning, quickly reached factories that produced sought-after goods. And with practical metallurgy to make iron rails and iron wheels cheaply, the fuse that was the Industrial Revolution was lit. Steam power propelled the automatic spindles, looms, metal presses, and railroad locomotives of the nineteenth century.

But the fuse might well have sputtered out. That, after all, is what the pre-1870 track record would lead one to expect. Printing, the windmill, the musket,

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THE INTERNATIONAL ECONOMY
THE MAGAZINE OF INTERNATIONAL ECONOMIC POLICY
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Washington, D.C. 20002
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the seagoing caravel, the water mill, and before that the horse collar, the heavy plow, the 3,600-soldier legion—each of these did revolutionize a piece of the economies and societies of their day. Yet none of them lit anything like the rocket of economic growth we have ridden since 1870. Ancient Mediterranean civilization was followed by what is rightly called a Dark Age. Printing revolutionized the dissemination of information, but books were always a small part of total spending, and the printing press was one revolutionary invention, not a series of them. The windmill and the water mill meant women no longer had to spend so much time nose to grindstone, but their fathers and husbands found other things for them to do instead. The musket and the caravel made the Imperial-Commercial Age and the gunpowder empires, but that, again, was a discrete jump rather than a takeoff into sustained growth. The horse collar and the heavy plow shifted the center of European settlement and commerce northward, but did not drastically improve the lot of Europe's working class. The legion was essential for the making of the Roman Empire, but it then reached the limits of its expansion, and eventually fell. What changed after 1870 was that the most advanced North Atlantic economies had invented invention. They had invented not just textile machinery and railroads, but also the industrial research lab and the forms of bureaucracy that gave rise to the large corporation. Thereafter, what was invented in the industrial research labs could be deployed at national or continental scale. Perhaps most importantly, these economies discovered that there was a great deal of money to be made and satisfaction to be earned by not just inventing better ways of making old things, but inventing brand-new things.

Not just inventions, but the systematic invention of how to invent. Not just individual large-scale organizations, but organizing how to organize. Both were essential to the arrival of the integrated, command-and-control central planning of modern corporations. Every year between 1870 and 1914 the newer and better industrial technologies that emerged from the first industrial research laboratories were deployed, sometimes as they were sold to already established producers, but more often as they spurred the emergence and expansion of large corporations.

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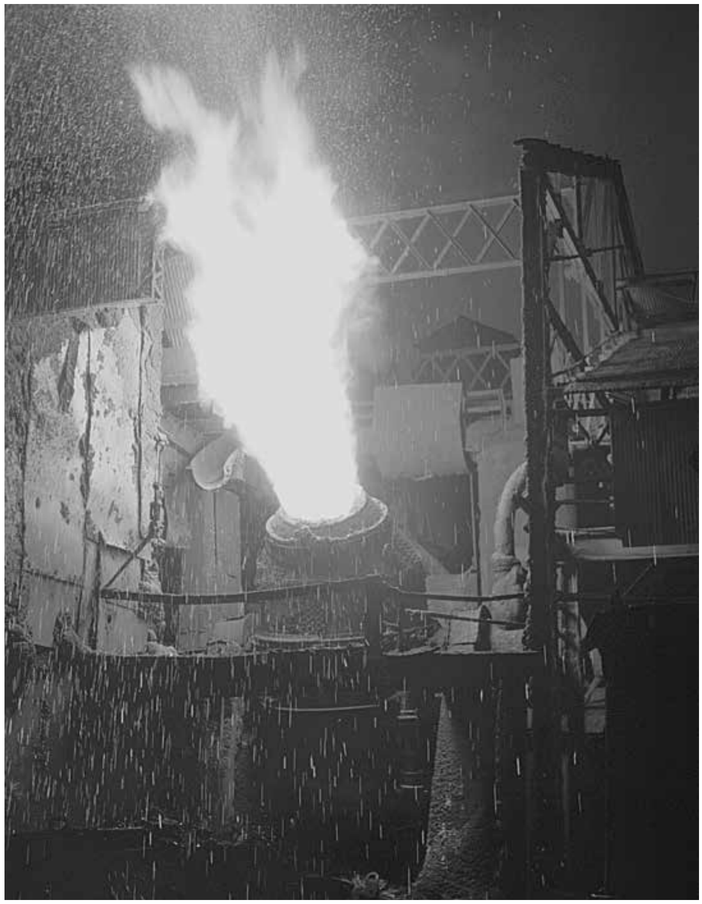

Molten iron is blown in an Eastern Bessemer converter to change it to steel at Republic Steel in Youngstown, Ohio, 1941.

As W. Arthur Lewis observed, a rich man in 1870 possessed the same things that a rich man in 1770 possessed. The 1870 rich might well have had more of those things—more houses, more clothes, more horses and carriages, more furniture. But displaying wealth was a matter of displaying the number of servants one employed, rather than the commodities one personally enjoyed. After the 1870s, that changed. The making of new commodities added a new twist, granting the rich access to, as Lewis put it, "telephones, gramophones, typewriters, cameras, automobiles, and so on, a seemingly endless process whose latest twentieth-century additions include aeroplanes, radios, refrigerators, washing machines, television sets, and pleasure boats." Four percent of Americans had flush toilets at home in 1870; 20 percent had them in 1920, 71 percent in 1950, and 96 percent in 1970. No American had a landline telephone in 1880; 28 percent had one in 1914, 62 percent in 1950, and 87 percent in 1970. Eighteen percent of Americans had electric power in 1913; 94 percent had it by 1950.

The arrival of these wonders of convenience and consumption is often called a "second industrial revolution." The economist Robert Gordon wrote of "one big wave" consisting of everything from flush toilets to microwave ovens, after which the low- and even the moderate-hanging fruit of organic chemicals, internal combustion engines, and electric power had been picked and technology was bound to slow. For him, the steady progress of science happened to suddenly bring us to a place extraordinarily rich in technological potential. But that, I think, misses much of the point: we associate these with a single "second industrial revolution" because they came in quick succession: instead of being spread out over a century and a half, as they would have been at the previous British Industrial Revolution–era pace, they arrived in a generation. What is most important is never so much the arrival of any particular technology as it is a burgeoning understanding that there is a broad and deep range of new technologies to be discovered, developed, and deployed.

Consider steel. What would be the fundamental building material of the twentieth century and the master metal of industrial civilization was effectively invented anew in the second half of the 1800s. Steel is composed of 90 to 95 percent iron mixed with carbon. You can make carbon-free wrought iron in your furnace if you keep its temperature below the melting point of iron and hammer it as the slag, or the various impurities in the iron, melt and run out, and then do this over and over again. But wrought iron is too soft for industrial purposes. If you heat your furnace with coke, a pure form of coal, and keep it high enough to melt the iron, the carbon from the coke alloys with it and you get pig or cast iron. But it is too brittle for industrial purposes.

Creating steel requires getting the details just right—but doing so is not easy.

For thousands of years steel was made by skilled craftsmen heating and hammering wrought iron in the presence of charcoal and then quenching it in water or oil. In the centuries before the nineteenth, making high-quality steel was a process limited to the most skilled blacksmiths of Edo or Damascus or Milan or Birmingham. It seemed, to outsiders—and often to insiders—like magic. In the Germanic legends as modernized in Wagner's Ring cycle operas, the doomed hero Siegfried acquires a sword made by a skilled smith. Its maker, the dwarf Mime, is in no respect a materials-science engineer. His brother, Alberich, is a full magician.

That changed in 1855–1856, when Henry Bessemer and Robert Mushet developed the Bessemer-Mushet process. It forced air through the molten cast iron to burn off all non-iron impurities, and then added back just enough carbon (and manganese) to make the steel needed for industry. The price of a ton of steel dropped by a factor of seven, from £45 down to £6, at a time when £70 per year was the average wage in Britain. The Thomas-Gilchrist and Siemens-Martin processes followed, offering further improvements. Worldwide steel production would rise from trivial amounts—enough for swords, some cutlery, and a few tools that needed the sharpest attainable edge—to some 70 million tons a year by 1914. By 1950 this would grow to 170 million tons, and as of 2020 it is 1.5 billion tons a year. As of 2016, steel cost about $500 per ton, and the average North Atlantic full-time wage was nearly $50,000 per year.

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But it was not just steel. Robert Gordon was 100 percent right when he wrote that the year 1870 was the dawn of something new in the world, for over the next several decades, "every aspect of life experienced a revolution. By 1929, urban America [had] electricity, natural gas, [the] telephone, [and] clean running water[,]… the horse had almost vanished from urban streets[,]… [and] the household… enjoy[ed] entertainment[s]… beyond the 1870 imagination." From the railroad and the steel mill as the high-tech edge of the economy in 1870, to the dynamo and the motor car as the high-tech edge in 1903, to the assembly line and the aircraft of 1936, to the television set and rocket (both moon and military) of 1969, to the microprocessor and World Wide Web of 2002—technological revolution, with its economic and then its sociological and political consequences, problems, and adjustments, came faster and more furiously than in any previous age. ◆