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Ken Sokoloff and the Economic History of Technology
An Appreciation

Joel Mokyr

The economic history of technology is a subfield of a subfield, and it is a small enough cell in the table of specialized areas of our discipline for all practitioners to know each other and read one another's work, often as journal referees and book reviewers. In such small fields, it appears there are two equilibria: either the field gets cooperative and friendly so that the participants communicate in an amicable and civilized style and do not let their professional disagreements interfere with personal judgment, or bloody internecine warfare breaks out, creating scenes worthy of a David Lodge. The difference between the two outcomes is often a single person or a few key individuals. A single scholar of impeccable stature, respected and liked by others, sets a tone that leads the participants to reconsider their position rather than be dismissive of other views, and may lead the entire field to a cooperative equilibrium. Alternatively, a leader's intolerance or egomania may create long chains of action and retaliation.

In the economic history of technology, for the period that Ken Sokoloff, myself, and a few others worked in, there was and is quite a bit of difference of emphasis and disagreement, but over the years the field remained cozy and friendly at best, respectful and polite at worst. Sokoloff commanded such widespread respect and affection, and his work was so solid and well-documented, that the entire field ended up for decades in the "good" equilibrium. It is also true, one might add, that the other major players in the area, especially Naomi Lamoreaux and Zorina Khan, as well as some of the

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best economists working in the area, such as Manuel Trajtenberg and Ariel Pakes, were his friends and collaborators.

Much of the debate, as might be imagined, was about the question of the sources of technological progress. For Ken Sokoloff, working in applied endogenous growth theory *avant la lettre,* incentives mattered above all. Throughout his extensive work in the area of innovation, a few themes emerged that consistently reflected the way he viewed the economics of technological progress. Invention, he believed, is by and large a rational activity, undertaken by individuals who calculate, at least at some level of approximation, their costs and benefits ex-ante before they decide to engage in the work that leads to invention. He full well realized that this activity, when undertaken at all, was highly sensitive to institutions that organized markets and thus set the rewards structure for would-be innovators, but he firmly believed that on the whole the supply of inventions was quite elastic. Provide this pool of would-be inventors with the right opportunities, Sokoloff argued, and the floodgates of invention will open.

In nineteenth-century America, he believed, these opportunities were provided by two main elements: patents and markets. In a duo of pathbreaking papers with Khan published in the early nineties in the *Journal of Economic History* (1990, 1993), Sokoloff and Khan showed that invention at this time was unique in being accessible and democratic and not confined to a narrow elite. Most American inventors were anything but eccentric cranks; they were by and large rational entrepreneurs responding to market opportunities and looking for profits. They had invested in the kind of human capital needed to develop inventions, mostly artisanal and machinist skills necessary to generate the incremental mechanical devices that were at the heart of American inventive activity in this age. They demonstrated that in the first half of the nineteenth century, the road to patent and benefit from invention was accessible to a significant segment of the U.S. population: artisans and machinists accounted for close to half of inventions. His and Khan's view was that American invention was above all open and competitive, driven by markets and incentives. In short, an "economic" activity in most dimensions.

It would be fair to say that in the literature on the economic history of technological progress, Sokoloff found himself to be a consistent demand-sider. For him, the fact that patents seemed to respond to business cycles and concentrate in areas with good access to markets constituted strong evidence that demand was predominant. This responsiveness to demand condition was for him the conclusive demonstration of the fact that invention was not exogenous (Sokoloff 1992, 354). In his view, those who focused on major technological breakthroughs, unduly focused "attention on the idiosyncratic aspects of all singular events" and "diminished the significance of general mechanisms at work" (347). This is not a wholly uncontroversial position, as it abstracted from the scientific origins of technological change—admit-

tedly a difficult and complex matter, but one in which Sokoloff saw of little interest. At this stage of his career his focus was on the technological development of the United States in the nineteenth century, when for most of the period invention consisted of mechanical contraptions and incremental microinventions that required little direct input of science. With some exceptions, the giants of science whose work was foundational to subsequent invention, men like Oersted, Gay-Lussac, Chevreul, Faraday, Ampère, and Liebig, were working in Europe and their additions to knowledge clearly were exogenous to American inventiveness (Sokoloff 1992, 368). In that sense, Sokoloff's vision of the process on this side of the Atlantic in that period was quite complete.

And yet, he carefully distinguished the American experience from that of other nations, where for one reason or another the opportunities to inventors were more limited to a privileged elite, perhaps less sensitive to market incentives and more driven by internal motives and peer pressures. In one of their best and most persuasive papers, published in the Berg and Bruland volume (1998), Khan and Sokoloff carefully compared the impact of different patenting environments on the nature of invention in the United States and Great Britain. Such comparisons, as they were fully aware of, are hazardous for many reasons, but they must be made nonetheless. In a later paper (Khan and Sokoloff 2004) they added, quite correctly, that it was the American system that was exceptional in its openness and in its recognition that "it was in the wide public interest that patent rights, like other property rights, be clearly defined, well enforced, and easy to transact in" (15). One gets the impression that Sokoloff himself clearly felt that such an open and accessible patent system was desirable and virtuous and the key to sustained invention.

These were and are not uncontroversial views. Patents have been denounced, most recently in a provocative book by Boldrin and Levine (2008), as rent-seeking monopolies, and the exact incentive effect they have on the propensity to invent (as opposed to the propensity to patent) is still subject to much debate (Mokyr 2009). Yet these are all, as the cliché has it, hard and complex issues on which reasonable scholars can disagree without being disagreeable. Ken would not have it any other way.

For Sokoloff, measurement and quantitative analysis was nondebatable. For an economic historian of technological progress, this poses, of course, a dilemma. Fundamentally, each invention is a sui generis and is made only once. Two separate inventions are inherently different, and "counting" them is subject to a number of serious objections. He thought long and hard about this matter, and as was appropriate for a Harvard grad student under the influence of the late Zvi Griliches, in the end he still found the use of patent data attractive; indeed, irresistible. He fully understood, better than most, the limitations of the use of patent data in the economic history of technology (Sokoloff 1992, 350). But he made enormous efforts to correct and

adjust for whatever biases these data imparted on the elusive measurement of inventive activity. The economics of the modern patent system is complex, and it was no different in eighteenth century Britain and nineteenth century America. Yet it has always attracted able economic historians (for instance, Rick Sullivan, Harry Dutton, Christine Macleod, and Petra Moser), in that it provides us with a measure at how invention really works on an aggregative and regional level. Much like looking at the night sky with a telescope, we understand that we only see a section of what we would like to see, and in many ways the blunt instrument we are using is distorting reality. But Sokoloff's ingenuity, curiosity, and energy overcame these objections as well as was possible.

The picture he painted of nineteenth century innovative activity is one that was comfortable to economists. Innovation was closely associated with markets—indeed, it itself was a market activity, in which technological ideas were sold and bought. As he showed in his first paper in this genre (Sokoloff 1988), inventive activity tended to be concentrated in areas in which markets were accessible and developed. Equally important, inventive activity followed the market for inventions: as his and Lamoreaux's fascinating paper on the glass industry (Lamoreaux and Sokoloff 2000) showed, not all producers were big inventors and not all inventors were big producers.

Clustering and agglomeration effects are all good and well, but in the Sokoloff view of the historical phenomenon of technological progress, the most important market was the market for knowledge, which he regarded as the key to the successful economy. He and Lamoreaux showed how essential the market for patent assignment became, and how its growth facilitated the growing and inevitable specialization between those who developed the new technology and those who were best positioned to use it (Lamoreaux and Sokoloff, 1996, 1999c, 2001). The existence of institutions in certain core regions that supported the marketing and sale of patents, such as patenting agents and lawyers and the availability of financial backing, was key to this interpretation, and lies at the heart of the geographical persistence of the cores of inventive activity (Lamoreaux and Sokoloff 1999b; 2009). These areas formed the "clusters" of inventive activity, with the agglomeration economies supplied by the institutional infrastructure rather than by some kind of knowledge spillover. More patents meant more assignments, and more assignments in turn helped build the "market" for technology. This in turn attracted more and more inventors to migrate to those regions, creating a positive feedback model of the kind that is used in economic geography.

By the late nineteenth century, in this interpretation, a class of ingenious, productive, full-time specialized inventors had emerged that were a "crucial source of new technological knowledge" (Lamoreaux and Sokoloff 2009, 53). These people lived by and for the patent system, and the better the inventor, the higher was his or her propensity to invent, to patent the invention, and to assign the invention to a producer who could make good use of

it. Apart from the fact that the product sold had some qualities that made it an unusual commodity, Sokoloff's work was much in the spirit of William Parker's famous characterization of U.S. economic history: "[W]hen all is said and done, the market did it again." It was a viewpoint consonant with a Northian view that saw growth occurring through better institutions that supported markets, with technological progress just a special case of the beneficial effects of good property rights, personal mobility, and well-functioning information-dissemination. It was a unique vision of the emergence of technological activity and its distribution over time, but one fully backed up by the data.

Yet within this general paradigm, Sokoloff was an empiricist who was professionally committed to let the data speak even when it did not always produce the results he expected. His deep knowledge of the development of innovation in the U.S. at both the national and regional levels forced him to revise his thinking about how American technology evolved: he saw that there was no direct transition between the single lone inventor working from his basement (or workshop) to the large corporate inventors that Schumpeter pointed to. In between there was a sophisticated, competitive, decentralized market, in which ingenious and increasingly professional inventors came up with a stream of inventive ideas, which they sold (or assigned) on the market after securing property rights to it through a patent.

Eventually, however, the American system he admired so much came to an end. The clusters of inventive activity in New England that had persisted throughout the nineteenth century started to decline in the twentieth century as manufacturing activity shifted away and the nature of inventions began to change. The growing complexity of technology required more and more fixed capital, and the old institutions that supplied credit to budding inventors were no longer adequate. Moreover, inventors increasingly needed formal scientific education instead of the informal training or even autodidactism that often sufficed before, and the "burden of knowledge" that successful inventors needed (to use a term employed by Jones [2009]), increasingly imposed barriers to what once was an open market. Rather than a self-employed entrepreneur, the typical inventor increasingly became an employee in a firm that in an earlier age would have licensed or bought his invention. At this stage of history, Schumpeter replaced North in his interpretation (Lamoreaux and Sokoloff 2009), although here, too, Sokoloff's vision was nuanced and sophisticated. Inventors in the twentieth century, much like their predecessors in an earlier age, had choices and exercised options, mostly in the rational fashion that an economist would expect.

Sokoloff was never one to shy away from some scholarly risk-taking and making some assumptions needed to validate his findings, as long as those assumptions, in the best traditions of cliometrics, were fully and explicitly spelled out. Those who had doubts, including myself, were engaged in debate, always agreeable and always informed and thoughtful. It was often

more pleasant to *dis*agree with Ken Sokoloff than to agree with other lesser scholars and gentlemen. Moreover, he was invariably generous, always giving other scholars credit for insights (even when those differed from his), always polite and respectful toward opponents. As a scholar, a teacher, and a colleague he led by example. The field of economic history has been impoverished by his untimely death, but his published work will continue to be read and studied, and the small but active field of the economic history of technology continues to thrive thanks to his leadership.

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