Joel Mokyr

THE MARKET FOR IDEAS AND THE ORIGINS OF ECONOMIC GROWTH IN EIGHTEENTH CENTURY EUROPE[1]

The roots of European economic growth in the nineteenth century must be seen in its intellectual background as well as in its economic environment. The closer interactions between different kinds of useful knowledge were prompted by the Enlightenment as, were institutional reforms which prevented economic growth from becoming a victim of predatory or opportunistic actions, as it had before. This leaves the emergence of the Enlightenment as the unresolved explanandum. It is argued here that the Enlightenment emerged from the fertile ground from a unique concatenation of circumstances: the political fragmentation of Europe, which made the suppression of innovators by the ruling orthodoxy and vested interests more difficult, coupled to an intellectual coherence that manifested itself in the transnational republic of letters. The resulting 'market for ideas' led to a competitive set-up in the sphere of intellectual activity, in which coherent and supportable ideas (or those that seemed that way at the time) had a fair chance to succeed, though this was never pre-ordained.

Two statements summarize much of the conventional wisdom about the historical experience of economic growth in the West: (1) Modern economic growth was ignited by the Industrial Revolution in the eighteenth century, and (2) the Industrial Revolution was, as everybody had always suspected, primarily about technology. Both statements must be qualified and nuanced: growth proper did not start until the second third of nineteenth century, and technology (to say nothing of 'industry') was not *all* there was to it. Yet when all is said and done, the place of technology in the economic miracle that occurred in Europe in the nineteenth century remains central. Technology, in its widest

1. I am grateful to Marianne Hinds and Michael Silver for loyal and competent research assistance. The comments of Avner Greif, two anonymous referees, and the editors of the *Tijdschrift voor Sociale en Economische Geschiedenis* on an earlier version are much appreciated. This article is a longer version of my Heineken lecture, given at the University of Groningen on Sept. 25, 2006.

sense, is about new ideas and the growth of useful knowledge.[2] Yet the economic impact of new technology, no matter how ingenious, can be realized only if the institutional environment is conducive and allows for the exploitation of inventions in an effective manner. In a simple economic model, it is hard to know whether conducive institutions 'cause' technological change or the other way around. It is arguable that neither are truly exogenous, and instead both depend on the formation process of ideologies and beliefs that follows its own rules.

Do ideas affect the outcomes of economic history? In a famous paragraph, John Maynard Keynes wrote that '...the power of vested interests is vastly exaggerated compared with the gradual encroachment of ideas ... soon or late, it is ideas, not vested interests, which are dangerous for good or evil'.[3] Most other economists are uncomfortable with this view, ironically enough agreeing with Marx that ideas were a superstructure determined by deeper economic forces, or as Marx himself famously put it in his *A Contribution to the Critique of Political Economy*, 'it is not the consciousness of men that determines their existence, but their social existence that determines their consciousness'.[4] Ekelund and Tollison have argued that 'The absence of any positive theory of idea formation or role for ideology leads us to support economizing activity as the primary explanation for institutional change... Ideology may be usefully be thought of as a "habit of mind" originated and propelled by relative costs and benefits. As an explanation for events or policies, it is a grin without a cat'.[5] Paul Samuelson, on the other hand, echoed Keynes in his widely-cited comment that 'let those who will write the nation's laws if I can write its textbooks'.[6] In the historical experience of European economic development, beliefs and the economic reality on the ground interacted in complicated ways. It is the purpose of this essay to unpack this interaction by introducing the concept of a market for ideas and demonstrating its historical relevance.

---

2. For a definition of useful knowledge and some caveats in it use, see Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton 2002) 2-15.
3. John Maynard Keynes, *The General Theory of Employment, Interest and Money* (London 1936) 383-384.
4. Karl Marx, *A Contribution to the Critique of Political Economy* (London: Lawrence & Wishart, 1971) 21.
5. Robert B. Ekelund and Robert D. Tollison, *Politicized Economies: Monarchy, Monopoly, and Mercantilism* (College Station (TX) 1997) 17-18.
6. See for instance: http://www.econlib.org/LIBRARY/Enc/bios/Samuelson.html (January 29, 2007).

A 'market' for ideas: a useful concept?

The concept of a competitive 'market' or 'marketplace' for ideas, while not entirely new, is rarely used in this context. It is most often used in the context of the commercialization of ideas in more concrete markets in intellectual property rights.[7] But even without such property rights, those who come up with new ideas seek to disseminate them in exchange for less tangible but equally desirable rewards. In other words, people with new ideas connect with potential 'customers' and try to *persuade* them of the merit of their idea. An idea is simply some well-defined intellectual unit that either is a description of reality or an interpretation thereof, a logical construct, or a set of instructions or recommendations. It includes anything between new techniques proposed by artisans and Luther's ninety-five propositions. The transaction can take place at arm's length between individuals who do not know each other, but in this period most of the time occurred through social networks of mutually acquainted scholars, especially through personal contact, correspondence, and publication.[8] Buyers selected from a 'menu' of new ideas, creating a Darwinian process of 'artificial selection'. If the seller managed to persuade the buyer, a 'sale' has taken place. For the seller this may mean a book sale or a lecture fee, but on the whole the gain from selling an idea to many buyers is reputational, fame often measured by such indicators as the number of citations or graduate students attracted. Reputations were desirable in and of themselves, and furthermore correlated with a variety of sinecures such as appointments at universities or courts. Such a market is a Schumpeterian construct in which competition is less between similar producers as between old and new techniques and commodities.[9]

The market for ideas is a market for a highly differentiated product and techniques. It is easy to raise objections to this metaphor: to start with, it is not all that clear whether 'persuasion' is a binary variable, and it makes more sense to define it as a more continuous process. It is riddled with high transactions costs and prices are poorly defined. Moreover, unlike standard markets, the sellers are rarely compensated by the buyers themselves, because ideas and

7. See for instance Joshua S. Gans and Scott Stern, 'The Product Market and the "Market for Ideas": Commercialization Strategies for Technology Entrepreneurs', *Research Policy* Vol. 32 (2003) 333-50.
8. Randall Collins, The Sociology of Philosophies: a Global Theory of Intellectual Change (Cambridge (MA) 1998).
9. As Schumpeter noted in a widely cited passage: 'In capitalist reality, as distinguished from its textbook picture it is not [price] competition which counts but the competition from the new commodity, the new technology...which strikes not at the margins of the profits of the existing firms but at their...very lives'. J.A. Schumpeter, *Capitalism, Socialism and Democracy* (New York 1950) 84.

knowledge are non-rivalrous and often non-excludable. Some other mechanism has to do that. Even when sellers are financially rewarded, there is rarely any proportionality between the social value of their contribution and their remuneration. Yet in terms of bringing together various elements that explain long-term historical change, the notion of a highly competitive market in which some allocation and outcome is achieved through decentralized and uncoordinated actions of many individuals each operating in his or her own interest is helpful. In other words, it is a concept that can explain the evolution of intellectual entities, in terms of the supply of novel ideas, the demand for them (as reflected by their success to persuade), and the environment in which the two came together.

The issues concerning which ideas are sold and bought at this market are at the heart of economic history. A large part of Europe's economic success was the result of the creation of new knowledge (innovation) and its dissemination by means of learning and persuasion. If a society were to harness technology in a systematic way to its program of 'Schumpeterian' (i.e., knowledge-based) economic progress, its intellectuals had to be concerned with natural phenomena and regularities that underlay the techniques in use, to pose the right kind of questions, and refrain from ruling out any areas of investigation. In other words, growth required an environment that created useful knowledge *of the right kind*. This environment was dominated by the manner in which the market for ideas operated in early modern Europe.

Where did the new ideas that underlay the economic growth of the eighteenth century come from? At the most basic level, of course, the very emergence of new ideas depended on the economy. Commercial and urban societies that could generate a surplus beyond subsistence, in which a substantial number of people could live by their wits rather than having to toil in the fields, were necessary if any intellectual innovations were to emerge. Only societies that had lifted themselves beyond bare agricultural subsistence could afford the leisure necessary to create learning. Economies that had accumulated enough wealth through a high agricultural productivity or commerce could afford to have the urban centers and non-farming classes that generated new knowledge.

Learning by itself was insufficient, however, to generate growth. Only when learning could be transformed into useful knowledge that could result in new and improved techniques did it become economically significant. Any such feedback from learning to the economy was historically contingent. Learning, no matter how deep and intellectually sophisticated, could be economically utterly sterile, and in many societies took the form of exegesis, mystical and occult-like studies, astrology, and the endless poring over and rehashing of legal, theological, and abstract philosophical issues. Such studies could be valuable, but their contribution to material welfare was limited. Useful knowledge could have an economic impact through innovation, if a certain institutional structure prevailed that not only helped create such knowledge, but also helped place it at the disposal of those who could use it best.

Moreover, for 'Schumpeterian' economic growth to occur, more was needed than an applied and practical research focus. For knowledge to be technologically productive and to affect material welfare, it had to be engaged in expanding what I have called the epistemic base of technology, that is, an understanding of the natural laws and regularities that make something work.[10] It was not sufficient to come up with new tricks and artifacts through trial and error. To be sure, new techniques evolved without anyone having much of a clue of why and how they worked, but these techniques typically crystallized soon and did not generate continuous advances. In the absence of an understanding of the natural processes that underlay techniques, it was much harder to find new applications for them and adapt them to changing circumstances.

The evolution of knowledge and ideology in Europe in the centuries before and during the Industrial Revolution was decisive in explaining Europe's subsequent economic performance. From the late middle ages on, what emerged in Europe was a much more competitive market for ideas in which intellectual innovators proposed theories, facts, observations, and interpretations of the world around them. Instead of a centralized coordinated system in which new ideas were vetted by the guardians of a monopolistic orthodoxy, the new set-up examined new ideas on their own merits, using the selection criteria of logic and evidence rather than conformity with the conventional wisdom. It created revolutions in astronomy, medicine, chemistry, mathematics, physiology, and many other areas.

By the late seventeenth century, out of that competitive market a complex but reasonably coherent set of ideas that we term 'the Enlightenment' emerged victorious. The Enlightenment was the crucial link between the emergence of the market for ideas and the emergence of economic growth in the West. It was not the *only* such link, and the interpretation proposed here does not maintain that such a market was the single mechanism that brought about the economic transformation of Western Europe. But it is one that was crucial to the history, and yet has hitherto received little attention.

The market for ideas is not a real market in the literal sense, but it is a useful metaphor. Just as other markets can be judged by their efficiency if they, for instance, observe the law of one price, we can examine the efficiency of a market for ideas. Three criteria should be emphasized here: consensus, cumulativeness, and contestability. Markets for ideas can be assessed as to whether there is a built-in tendency to converge to a *consensus*. Knowledge can be characterized as *tight* when it is held by a wide consensus with high confidence.

10. Mokyr, *The Gifts*, 13-16.

Much of the knowledge in the areas crucial to modern economic growth in chemistry, biology, and physics, and which is held with a high degree of tightness in modern society, was the subject of heated debates in the seventeenth and eighteenth centuries, the resolution of which was sometimes difficult.[11] It is when knowledge is untight that coercion can play an important role in deciding outcomes in the market for ideas. Part of the platform of the Enlightenment, therefore, was to leave no stone unturned in its efforts to make knowledge tighter by confronting hypotheses with evidence and by allowing more and more evidence as admissible. In this effort, it failed more often than it succeeded, but the effort itself was significant. Another efficiency criterion for the markets for ideas is whether they were *cumulative,* that is, whether they retained the information that had been selected. Without some mechanism that preserved knowledge and made it available in the future, each generation would have to re-invent a few wheels, and worse, some important knowledge might have been lost. This depends to some extent on the efficacy of the institutions in charge of passing knowledge from generation to generation, and their technological support in knowledge-storage devices such as books and artefacts.[12] Yet cumulativeness could become an encumbrance if it degenerated into orthodoxy, and therefore the third component of efficient knowledge markets, *contestability,* is critical. No social system of knowledge can work without some notion of authority, but in a well-functioning market for ideas there should be no sacred cows and no belief should be beyond challenge. Market theory teaches us that free entry creates on the whole a more salutary outcome than a monopolist.

The idea of a Schumpeterian market for ideas immediately implies the concept of an intellectual *entrepreneur*. Such figures can be discerned with ease in the centuries before 1750. Many of these people were, of course, selling their own ideas. However, a market for ideas is not confined to *new* ideas, and the distinction between the existing stock of ideas and a flow of new ones is quite important. The Renaissance, after all, is often associated with the initial revival of old ideas, though many of these were eventually criticized, revised, or rejected. In the age of Enlightenment Europe was especially rich in such entrepreneurs trying to market the ideas of others, but this phenomenon was surely not new in the eighteenth century. After Copernicus's death, some of Europe's most distinguished intellectuals converted to his views and spent their time

---

11. Thus, for instance, scientists could not decide on the nature of heat, and while they were getting better at measuring and controlling it, they were unsure of what its real essence was.
12. This point is well-made by Richard G.Lipsey, Kenneth I. Carlaw and Clifford T. Bekar, *Economic Transformations: General Purpose Technologies and Long-term Economic Growth* (Oxford 2005) 260, when they discuss the importance of what they call institutional memory.

and efforts persuading others. Newton, above all, was followed by a coterie of 'Newtonians' who tried to sell his ideas to others. Among these people, the Dutch academic Willem 's Gravesande deserves special mention, as does Mme. du Châtelet, one of the first notable women in the European intellectual marketplace.

Unlike the standard entrepreneurs as pictured by economists, intellectual entrepreneurs are not motivated solely by profit maximization but rather have more complex utility functions. The writers, lecturers, publishers, and experimenters of the eighteenth century who jointly made the Enlightenment were generally persuaded that they were serving values such as Truth and Justice. Many were convinced that the new knowledge of nature or novel concepts of society and the economy would help make the world better. Many of them were also driven by ambition, a need to impress their friends, and a desire to prove their ability to themselves.[13] The market for ideas is in part a signaling game in which intellectuals try to establish their 'quality', a feature presumably correlated with patronage and sinecures. Greed, ambition, curiosity, and altruism all played a role.

The two centuries before the Industrial Revolution, then, witnessed developments in the European intellectual marketplace that were crucial in creating a world in which useful knowledge played an increasing role in expanding the economic opportunities of Western nations, and eventually became the dominant element in productivity growth. This was a slow and uneven process, but it was also relentless and cumulative, and by the early nineteenth century it was sufficiently powerful for technological innovation to turn from a sporadic and ephemeral exception in a few sectors into a phenomenon that became increasingly routinized and widespread in the economy. Next to the changes in the markets for goods, labor, and capital, which is the standard fare of every undergraduate course in economic history, the Industrial Revolution was preceded by far-reaching developments in the less visible market for ideas and knowledge that affected economic activity through channels that can be observed only indirectly but that in the long run were decisive to the fate of the economy.

The market for ideas is one in which those who have new ideas try to 'sell' them, that is, convince others of their merit. For this process to work, it needed shared rhetorical conventions and signals that could help potential 'customers' determine the merits of proposed new ideas. In natural philosophy,

---

13. To be sure, as the modern economics of open source technology has emphasized, many of these motives were themselves correlated with income. In the seventeenth and eighteenth centuries, fame and reputation were conditions for university professorships or patronage jobs in a variety of courts, from Galileo's comfortable appointment at the court of the Medicis to Newton's sinecure at the British mint.

mathematics, medicine, and engineering, certain standards were established that determined the criteria for acceptance and rejection of new propositions. The market for social and political ideology worked differently, to a degree. Its standards did not have to be nearly as tight, and much depended on rhetoric, religion, and political interests.

To be more precise, a market for ideas that generates technologically- or ideologically driven economic growth requires four elements: agenda, capability, selection, and diffusion. The supply side in the market for ideas was determined largely by the first two, and the demand side by the other two. I now address these four elements.

Agenda

Terms such as 'research' or 'development' are a bit anachronistic as far as the seventeenth century is concerned. However, there is no doubt that in the century before the Industrial Revolution there was considerable progress in what we would call today science and what contemporaries termed 'natural philosophy'. Whether or not the advances in physics, chemistry, astronomy, and mathematics between Galileo and Leibniz deserve the term 'scientific revolution' remains in dispute. What matters is that the age became more and more enchanted with the term 'useful knowledge', which was increasingly interpreted in a literal sense. This concept became the basis for the 'Baconian program', and increasingly served as the key to the agenda of researchers. The idea, in summary, was that knowledge was supposed to be 'useful' – morally, socially, and increasingly, materially. Society was *improvable* through knowledge, and the purpose of the study of nature and experimentation was to help solve practical problems just as much and eventually more so than to satisfy human curiosity or to demonstrate the wisdom of the creator.[14] Many, if not most of the natural philosophers of the age of enlightenment agreed with Bacon's notions and acknowledged their intellectual debt to his ideas.[15]

---

14. The 'business of science', John T. Desaguliers noted in the 1730s, was 'to make Art and Nature subservient to the Necessities of Life in joining proper Causes to produce the most useful Effects'. This was spoken by one of the leading Newtonians of the time, a man who made a career out of selling knowledge to others, a professional lecturer, a textbook writer, and a consultant to business. John T. Desaguliers, *A Course of Experimental Philosophy* (third edition, 3 Vols. London 1763) Vol. 1, p. iii.

15. By 1700, when Leibniz proposed an Academy for Berlin, he explicitly noted that its purpose should be to engage in useful research, as opposed to mere 'curiosity'. Peter Burke, *A Social History of Knowledge* (Cambridge 2000) 44-46.

The knowledge accumulated by natural philosophers in the eighteenth century could only rarely be applied directly to production, and a straight link between the Scientific Revolution and the Industrial Revolution cannot be defended. It is telling, however, that many scholars used their rigor and training to attack practical problems. Among them were the greatest minds of the scientific enlightenment.[16] A shift in the agenda had occurred. Rather than just gazing at the stars, dabbling in the 'occult,' or making metaphysical points about the wisdom of the creator, a new, practical, and down-to-earth natural philosophy emerged in the late seventeenth and eighteenth centuries, produced by people who felt that the world could be improved by their knowledge. This knowledge was increasingly derived from and applied to the mundane world of crafts, farming, and services. Thus, intellectuals were attracted to technology and its mysteries more than ever before, as embodied in the early work of the Royal Society.[17]

It is remarkable that the belief in this mission remained indefatigable in the face of continuous frustration and disappointment (although the Royal Society itself lost its fascination with technology after 1700). And there was plenty of frustration and disappointment. A case in point is William Cullen, a Scottish physician and chemist. His work 'exemplifies all the virtues that eighteenth-century chemists believed would flow from the marriage of philosophy and practice'.[18] Ironically, however, this marriage remained barren for many decades. Cullen's prediction that chemical theory would yield the principles that would direct innovations in the practical arts remained, in the words of the

---

16. Leonhard Euler was concerned with ship design, lenses, the buckling of beams, and (with his less famous son Johann) contributed a great deal to theoretical hydraulics. The great Lavoisier worked on assorted applied problems as a young man, including the chemistry of gypsum and the problems of street lighting. Gottfried Wilhelm Leibniz, Benjamin Franklin, Joseph Priestley, Tobern Bergman, Johann Tobias Mayer, and René Reaumur were among the many first-rate minds who unabashedly devoted some of their efforts to solve mundane problems of technology: how to design calculating machines, how to make better and cheaper steel, how to build better pumps and mills, how to determine longitude at sea, how to light homes and cities safer and better, how to prevent smallpox, and similar questions.

17. In the words of Thomas Sprat, an early defender of the Society, its mission was to create a natural philosophy that would benefit 'mechanicks and artificers'. 'The business and design of the Royal Society is to improve the knowledge of natural things, and all useful Art, Manufactures, Mechanick practices, Engynes, and inventions by Experiments.... . The Fellows of the Royal Society have one advantage peculiar to themselves, that very many of their number are men of converse and traffick, which is a good omen that their attempts will bring philosophy from words to action, seeing men of business have had so great a share in their first foundation' wrote Robert Hooke in 1663, quoted in Henry Lyons, *The Royal Society 1660-1940: A History of its Administration under its Charters* (London 1944) 41-42.

18. A.L.Donovan, *Philosophical Chemistry in the Scottish Enlightenment* (Edinburgh 1975) 84.

leading expert on eighteenth-century chemistry, 'more in the nature of a promissory note than a cashed-in achievement'.[19] Manufacturers needed to know why colors faded, why certain fabrics took dyes more readily than others, and so on, but as late as 1790, best-practice chemistry was incapable of helping them much.[20] Before the Lavoisier revolution in chemistry, it just could not be done, no matter how suitable the social climate: the minimum epistemic base simply did not exist.

In many other areas, despite the best of efforts and intentions, the new research agenda yielded few tangible results. Although medical science made a few significant advances before 1850, compared with the enormous tasks of combating infectious diseases, these achievements were comparatively modest.[21] Another example is the exploration of electricity. The eighteenth-century natural philosophers were fascinated by this strange force, and believed that once tamed, it held great promise. While advances in electricity such as the Leyden jar (invented in 1746), the discovery of different levels of conductivity, and the finding that electricity could be transmitted over considerable distances all stirred many an imagination, and some entertaining uses were found for the mysterious phenomenon, practical applications had to await the breakthroughs of Oersted, Faraday, and Ampère in the first half of the nineteenth century.

An exception was Franklin's lightning rod (1749), one of the first useful pragmatic applications of experimental science.

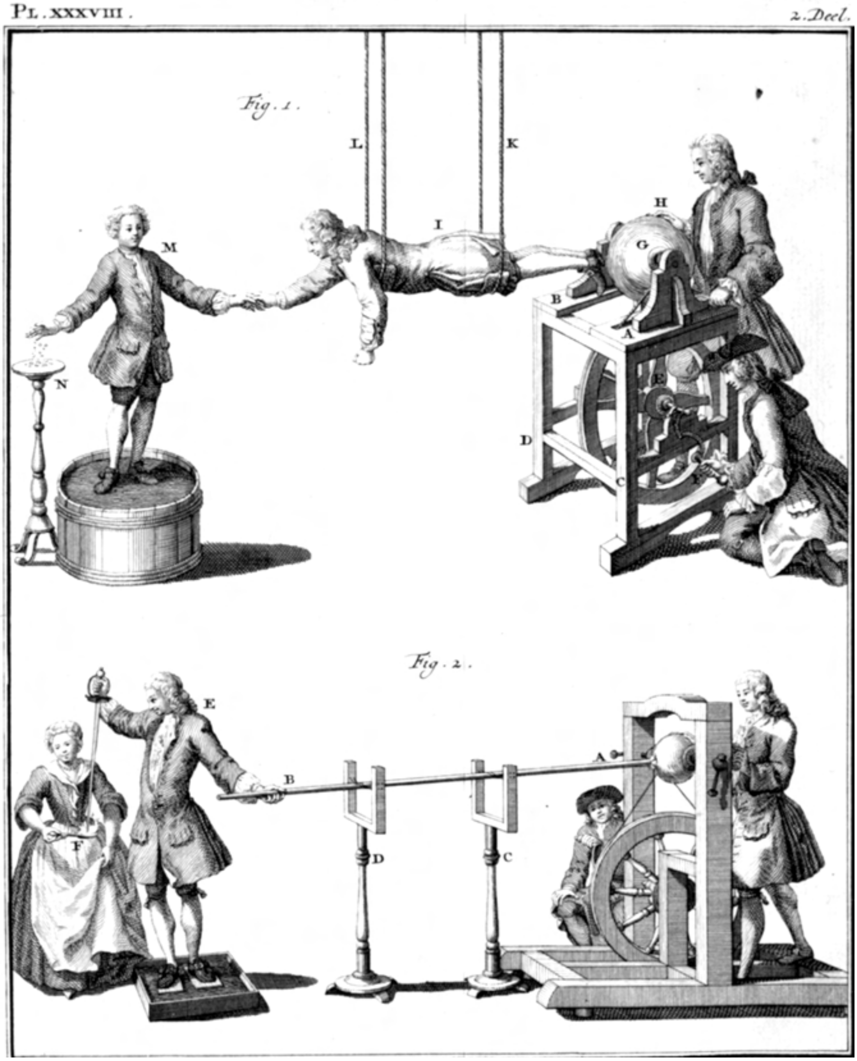
It is important to realize how much effort was spent in this age on unsuccessful research. Rather than indicating an inefficient allocation of resources, this shows of course that new knowledge creation is inherently wasteful. Progress was limited by the constraints of a world in which engineers, physicians, farmers, industrialists, and mine-operators knew preciously little about the fundamental physical and biological rules that governed the techniques they used. These techniques had slowly emerged over the ages, the result of the patient accumulation of experience, trial and error, and serendipity. The width of the epistemic base determined the effectiveness of the research program, though the degree to which propositional knowledge was a constraint varied

---

19. Jan Golinski, *Science as Public Culture: Chemistry and Enlightenment in Britain, 1760-1820* (Cambridge 1992) 29.

20. Barbara Whitney Keyser, 'Between Science and Craft: the Case of Berthollet and Dyeing', *Annals of Science* 47, 1990 no. 3 (May) 222.

21. Among those were the discovery by British naval officers that fresh fruits and vegetables could prevent scurvy, the use of cinchona bark (quinine) to fight off the symptoms of malaria, the prescription of foxglove (now known as digitalis) as a treatment for edemas and atrial fibrillation (first recommended by Dr. William Withering, a member of the Lunar Society, in 1785), the consumption of cod liver to prevent rickets, and above all the miraculous vaccination against smallpox discovered by Jenner in 1796.



Desaguliers translated into Dutch: Joann. Theoph. Desaguliers, De natuurkunde uit ondervindingen opgemaakt uit het Engels vert. door een liefhebber der natuurkunde *(Amsterdam: Isaak Tirion, 1746-1751) 3 dln. Vol. 2, plate 38, 436: Tests with static electricity.*

enormously from field to field. When techniques were not based on a systematic understanding of why things work, people trying to improve upon them will not be able to rule out dead ends and blind alleys nearly as efficiently. Alchemy remained a popular activity until the eighteenth century and the search for *perpetuum mobile* engines continued until the mid nineteenth century.

For most areas in technology, the gradual widening of the epistemic base was necessary to attain an increase in the efficiency of the R&D process. All the same, some remarkable achievements could be made without the support of such a base – such as the successes of British animal breeders in improving the quality of livestock without the benefit of genetics and physiology, but advancing diligently and systematically using rules-of-thumb based on experience rather than theory. High quality steel was produced by Benjamin Huntsman in the 1740s long before the chemical nature of steel was identified. The smallpox vaccination process, developed in the middle of the Industrial Revolution, stands as an example of how history-changing innovations could be achieved without much of an epistemic base.

The idea of turning research into useful knowledge was larger than the discovery of underlying general laws. Description and organization mattered as much. Much of the investigations of the eighteenth century were in the style of the 'three C's': counting, cataloguing and classifying. Taxonomy, often dismissed as a form of knowledge, was quite central to the market for ideas in the eighteenth century. In that regard, the great figures were the Swedish botanist Carl Linnaeus and his French rival Georges-Louis Buffon, but many contemporaries followed them in attempts to gather more information about living beings so that farming and husbandry could be improved. In Britain the paradigmatic figures were Erasmus Darwin and Joseph Banks, the authors of voluminous books on plants and animals, and Arthur Young and John Sinclair, who wrote extensively on agriculture. These writings did not have immediate results: agricultural productivity increased only slowly in the period of the classical Industrial Revolution, and insofar that it did, it was probably not much due to agricultural writings.[22] And yet, the demand side of the market for ideas was there, and the supply was on the way. The market was supported by the belief that more and better knowledge would eventually lead to human progress.

The Baconian program, then, became the dominant force in determining the agenda of intellectual activities of enlightenment *philosophes*. The results, at least in the eighteenth century, were disappointing and much delayed. The debate between those who feel that science played a pivotal role in the Industrial Revolution and those who do not is more than the hackneyed question whether a glass is half full or half empty, because the glass started from empty and slowly filled in the century and half after 1750. Scientists and science (not quite the same thing) had a few spectacular successes in developing new production techniques, above all the chlorine bleaching technique and the inventions made by such natural philosophers as Franklin, Priestley, Davy, and

---

22. Voltaire in his famed *Philosophical Dictionary* caustically remarked that after 1750, many useful books written about agriculture were read by everyone but the farmers. Voltaire, *Dictionnaire philosophique: dans lequel sont réunis les questions sur l'encyclopédie, l'opinion en alphabet, les articles insérés dans l'encyclopédie* (Paris: Didot, 1816) Vol III, 91.

Rumford.[23] The efforts made by Europe's most eminent learned men to improve practical techniques demonstrates that by the second half of the eighteenth century most scientists felt an acute responsibility to the material world, and made a sincere effort to learn which problems bothered people in the workshops and the fields. These efforts were enforced by commercial interests that created a literal market in knowledge. An increasing number of British natural philosophers and learned persons found it remunerative to rent out their services to manufacturers as consultants.[24]

Capabilities

As noted, progress in science is constrained by the ability of scientists to answer questions and to pose the right ones. One of the great insights of the historian of science Derek Price was to illustrate the extent to which instrumentation, observation, and computational limits constrained the development of science.[25] Experiments and observations depended on research techniques, and without the right instruments and materials, the most enlightened and well-meaning research programs would fail. An atmospheric steam engine, for instance, required the notion of a vacuum, but would have been unlikely in a world without a vacuum pump. The great advances made by Lavoisier and his pupils in debunking phlogiston chemistry were made possible by the equipment manufactured by his colleague Laplace, who was as skilled an instrument-maker as he was brilliant a mathematician. Scientific advances were made possible by progress in the tools and equipment that scientists had at their disposal. In that sense, the simple causal arrow leading from propositional knowledge to technology was complemented by a positive

---

23. At times major breakthroughs remained barren for many years. Thus, the most spectacular insight in metallurgical knowledge, the celebrated 1786 paper by three of France's leading scientists, Monge, Berthollet, and Vandermonde that established the chemical properties of steel, had no immediate technological spin-offs. It was 'incomprehensible except to those who already knew how to make steel'. John R. Harris, *Industrial Espionage and Technology Transfer* (Aldershot 1998) 220. Harris adds that there may have been real penalties for French steelmaking in its heavy reliance on scientists or technologists with scientific pretensions.

24. Among the best-known ones in the early eighteenth century were the Scottish chemist William Cullen and the itinerant lecturer and Newtonian Jean T. Desaguliers. During the Industrial Revolution, the number of these consulting engineers expanded and they organized into the Smeatonian Society named after John Smeaton, Britain's leading engineer.

25. Derek J. de Solla.Price, 'Notes towards a Philosophy of the Science/Technology Interaction', in: Rachel Laudan (ed.), *The Nature of Knowledge: are Models of Scientific Change Relevant?* (Dordrecht 1984) 105-114. Price refers to scientific advances made possible by better tools as 'artificial revelation'.

feedback mechanism from technology to science, creating a self-enforcing cumulative process.

Improved instruments and research tools played important roles in a range of 'enlightenment projects' that might be seen as technological improvements with poetic license. One such improvement was the use of geodesic instruments for surveying.[26] Time, too, was measured with increasing accuracy, which was as necessary for precise laboratory experiments as it was for the solution to the stubborn problem of longitude at sea. Experimental engineering also made methodological advances. John Smeaton was one of the first to realize that improvements in technological systems can be tested only by varying components one at a time holding all others constant.[27] In such systems, progress tends to be piecemeal and cumulative rather than revolutionary, yet Smeaton's improvements to the water mill and steam engine increased efficiency substantially even if his inventions were not quite as spectacular as those of James Watt. One of the most path-breaking innovations in the capabilities of scientists to establish natural phenomena and regularities was the use of electrolysis in chemical analysis. This became possible in 1800 with the invention of the first battery-like device that produced a steady flow of direct current at a constant voltage, namely Alessandro Volta's pile of 1800. Its ability to separate elements in the newly proposed chemistry filled in the details of the landscape whose rough contours had been outlined by Lavoisier and his students.[28]

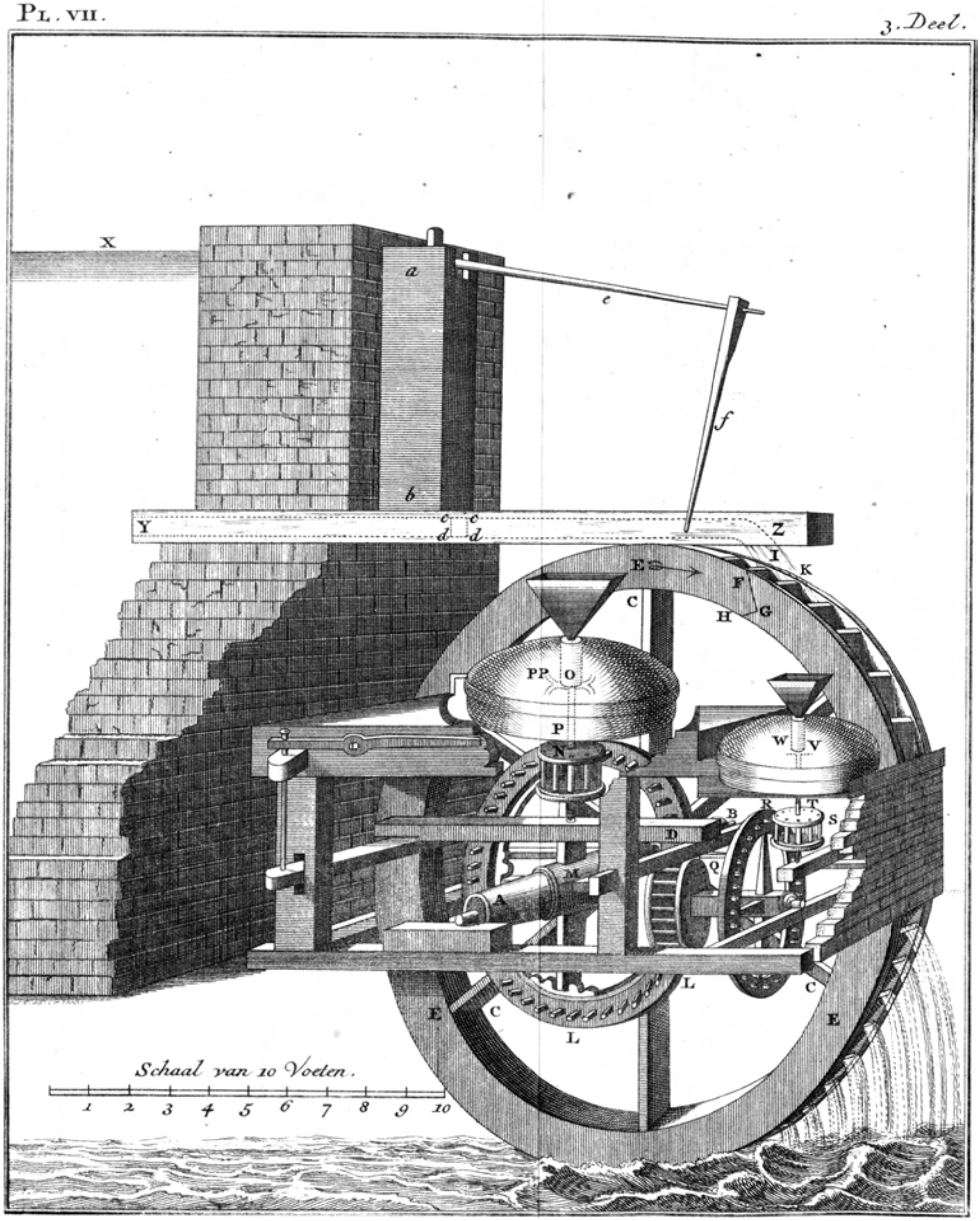
Another increased capability came from mathematics. The use of mathematics in scientific research was itself hardly new in the seventeenth and eighteenth centuries, but advances in mathematics added new tools to the arsenal of engineers, and theoretical work in engineering advanced consequently and – with a considerable lag – expanded the supply of good ideas. Mathematics increasingly became a problem-solving technology and many great mathematicians lent their skill to computations that had useful applications in ballistics, engineering, astronomy, and navigation. Copernicus's student, Rheticus, prepared complete tables for all six trigonometric functions, and Napier developed logarithmic tables. Computing tools such as Galileo's 'compass' and Pascal's early calculating machine were designed, though the inability of

---

26. Jesse Ramsden designed a famous theodolite that was employed in the Ordnance Survey of Britain, commenced in 1791. A comparable tool, the repeating circle, was designed by the great French instrument maker Jean-Charles Borda in 1775, and was used in the famed project in which the French tried to establish with precision the length of the meridian.

27. D.S.L. Cardwell, 'The Academic Study of the History of Technology', *History of Science, an Annual Review of Literature, Research and Teaching*, 1968 Vol. 7, 120.

28. As Humphry Davy, perhaps the most accomplished practitioner of the new electrochemistry put it, Volta's pile acted as an 'alarm bell to experimenters in every part of Europe'. As cited by William H. Brock, *The Norton History of Chemistry* (New York 1992) 147.



Desaguliers translated into Dutch: Joann. Theoph. Desaguliers, De natuurkunde uit ondervindingen opgemaakt uit het Engels vert. door een liefhebber der natuurkunde *(Amsterdam: Isaak Tirion, 1746-1751) 3 dln. Vol. 3, plate 7, 58: Overshot-wheel.*

mechanics to construct them at low prices limited their use. The input of formal mathematics into technical engineering problems in hydraulics and the design of better waterwheels was remarkable in the late eighteenth century.

These attempts reflect both the potential and the difficulties of the learning process in applying the newly invented calculus to the dynamic problem of hydraulics.[29]

Calculus, developed in the late seventeenth century, eventually found many applications in mechanical engineering as well as in construction.[30] Calculus, indeed, may be regarded a ‘General Purpose Principle’, in the terminology of Lipsey, Bekar, and Carlaw: a multi-purpose tool that allowed for any function to be maximized and laws of dynamics written down and solved.[31] Again, the French led their more pragmatic and less formal British colleagues. The great three French polytechniciens of the early nineteenth century, Gustave-Gaspard Coriolis, Jean-Victor Poncelet, and Louis Navier, placed mechanical and civil engineering on a formal base, and while the immediate impact of these advances on productivity is difficult to discern, it is hard to see how sustained progress in the longer run could have been made without it. The same holds for the study of electricity: eighteenth century science grappled bravely with the topic, combining experimental work with theory. The mathematical work of Franz Aepinus (1759) provided the first systematic epistemic base for the findings of experimentalists such as Van Musschenbroek, starting a long chain of investigation that would bear fruit more than a century later.

An early example of the improved capability is Galileo’s realization that models of machines were not linearly proportional to their full-sized counterparts, but that one had to take into account the disproportional relations between weight and volume and the nonlinear mechanical action of levers and pulleys. While the idea of the lever goes back to classical times, Galileo extended it to the dynamic operation of machines. In his *Discorsi et Dimostrazioni Matematiche* (1638), he laid the foundation for a general theory of mechanics or ‘kinematics’. These ideas were especially influential in eighteenth-century France, leading to more formal theories of engineering, such as Antoine Parent’s theory of the strength of beams. Galileo’s approach to practical problems was thoroughly pragmatic, emphasizing the economic efficiency of machines rather than their physical capacity.

---

29. The French mathematician Antoine Parent calculated that the maximum useful effect of a waterwheel was only 4/27th the natural force of the stream and that the optimal speed of the waterwheel was 1/3 that of the stream. These calculations were widely accepted, although they were incorrect and did not square with empirical observations. They were subsequently revised and corrected. Experimental work remained central and at times had to set the theorists straight. Terry S. Reynolds, *Stronger than a Hundred Men: A History of the Vertical Water Wheel* (Baltimore 1983).

30. A celebrated example is the development of the theory of beams, in Charles Coulomb’s celebrated 1773 paper ‘Statical Problems with Relevance to Architecture’.

31. Lipsey, Carlaw and Bekar, *Economic Transformations*.

Selection

The modus operandi of demand side of a market for knowledge is selection by the constituency of the market. How do 'consumers' choose from the menu of ideas and theories presented to them? This question is the foundation of the field of evolutionary epistemology and was popularized by Richard Dawkins and his concept of 'memes' compete for acceptance within human society. Hull presents a more powerful image of evolutionary selection mechanisms in the market for a set of ideas.[32] Rather than survey those debates, I accept the notion proposed by Richard Dawkins and E.L. Hull (although they differ in the details) that science and technology consist of units that struggle for acceptance in a Schumpeterian market. Techniques (or prescriptive knowledge) compete for acceptance for the simple reason that there are more ways to skin a cat than there are cats. The production set bound by the isoquant, that is, the set of feasible techniques, to use the lingo of economics, is selected upon by criteria that are related to profit maximization. Propositional knowledge, of which science is a part, follows more complex selection criteria.[33] The fundamental mechanism at work here, as already noted, is not one of cost minimization, but one of *persuasion*. Society constructs certain rhetorical conventions by which logic and evidence are admissible in arguments about ideas, and these conventions set the rules of the game, or the underlying institutions, in the market for ideas. A naive view of this process would only select among competing alternatives by the criterion of the maximal likelihood that they were 'true'. By that logic, astrology would have disappeared centuries ago.

Some scholars such as Ian Inkster recommend the use of terms such as 'reliable' or 'tested' knowledge.[34] However, what is meant by 'reliable' and how the tests are to be carried out are themselves dependent on specific circumstances. In fact, it is not even true that societies need to choose between inconsistent theories; consistency itself is a criterion that is contingent and time- and society-specific. The logic of Western thought has normally been that a proposition is either true or false, that two mutually contradictory propositions cannot both hold, and that new paradigms replaced old ones, but this methodology itself is historically contingent.

---

32. David L. Hull, *Science as a Process* (Chicago 1988).
33. Joel Mokyr, 'Useful Knowledge as an Evolving System: the View from Economic History', in: Lawrence E. Blume and Steven N. Durlauf (eds.), *The Economy as and Evolving Complex System, Vol. III: Current Perspectives and Future Directions* (New York 2006) 307-337.
34. Ian Inkster, 'Potentially Global: A Story of Useful and Reliable Knowledge and Material Progress in Europe, ca. 1474-1912', http://www.lse.ac.uk/collections/economicHistory/GEHN/GEHNPDF/PotentiallyGlobal-IInkster.pdf (January 29, 2007).

For economic history, what matters is not only pure 'useful knowledge', that is, ideas about the physical environment, but also beliefs about the character of the economic game and the functions of economic policy. In this respect, the eighteenth century witnessed a wave of new, enlightened ideas that shared a growing aversion to what we would today call 'rent-seeking,' from predatory wars to exclusionary privileges enjoyed by a select few. The debates between enlightenment *philosophes* and those who defended some aspect of the mercantile system were no less crucial to the long-term economic outcome than were the ones about caloric and phlogiston.

To understand why and how the Enlightenment could take place, we need to recognize the prior changes in the market for ideas in the European West. How and why did this happen? How did the selection process among competing ideas change in the eighteenth century? Existing knowledge and ideas tend to develop into orthodoxy, and incumbents are defensive and jealous. Many entrenched elites found ingenious ways to perpetuate the status quo, so that intellectual innovation would be only admissible if it did not contradict the existing orthodoxy. Conservative establishments in science, religion, and political thinking argued that the predominant criterion for the acceptance of novel knowledge was that it be consistent with existing ideas. New ideas and techniques that were inconsistent with the intellectual or technological status quo, and could thus threaten the human capital of those who were in control of the existing knowledge, were to be suppressed, by force if necessary.[35] Intellectual innovation could only occur in tolerant societies in which possibly outrageous ideas proposed by sometimes highly eccentric men would not incur violent responses against 'heresy' and 'apostasy'. This was especially true in a world in which science, philosophy, and religion were intimately connected. In the late Middle Ages, the intellectual innovations of the twelfth and thirteenth centuries had rigidified into a Ptolemaic-Aristotelian canon that became increasingly intolerant of deviants. Cosmology and theology in the picture of the world that emerged were deeply intertwined and provided an intellectual foundation of the religious establishment. 'The resulting system of the Universe was considered impregnable and final. To attack it was considered

---

35. The explanations of how such intellectual conservatism can be a rational response can vary . See Timur Kuran, 'The Tenacious Past: Theories of Personal and Collective Conservatism', *Journal of Economic Behavior and Organization* 1988 Vol. 10, 143-171. It was often felt that a free marketplace for ideas might lead to subversion that threatened political stability (that is, the power base of the status quo), or that they might cause economic disruption such as unemployment. In other cases, still not entirely absent in our own age, disrespect toward the wisdom of elders or the presumption of appropriating powers that belong to a higher being ('playing God') are also resented. Symbolic tales like the sorcerer's apprentice and Prometheus embody the notion that innovation could be dangerous and should be contained and controlled.

blasphemy'.[36] Yet from 1500 on, this system came under increasing pressure and eventually collapsed.

To phrase it differently, the market for ideas can rely on any combination of persuasion and coercion. Coercion can, of course, be viewed as nothing more than a special form of persuasion, used at times to spread new ideas (e.g., early Christianity and Islam), but more commonly to protect and defend an existing orthodoxy. At some level, of course, it is impossible to force people to believe in something that they find inherently unacceptable. Coercion, however, can work through control of channels of knowledge transmission such as education, churches, censorship, and propaganda. More insidiously, it can work through the persecution of those who have the potential to propose new ideas, thus affecting incentives by raising the expected costs of innovation and discouraging the development of new ideas.[37] The exact timing of the decline of orthodoxy in Europe is not easy to establish. Although the challenge to the incumbency seems to have become more pronounced in the sixteenth century, when the Reformation overthrew the existing religious order and forced considerable changes on the Church, that kind of simple timing is not wholly satisfactory. Religious reformers could themselves be conservative in other areas, and many intellectual innovations took place in Catholic lands.[38] The rise of tolerance was far from monotonic, and even the Papacy experienced periodic swings of progressivism and reaction.[39]

---

36. Andrew Dickson White, The Warfare of Science with Theology (New York 1896) 120; Lipsey, Carlaw and Bekar, *Economic Transformations*, 237.

37. The Chinese institution of examination for the Civil Service, ostensibly the most meritocratic institution of the world, tested the students on their knowledge of Confucian philosophy, and did not tolerate major deviations, much less knowledge that came from other societies. Because Judaism before the nineteenth century, despite its intellectual character, was backward looking and based on the assumption that all wisdom had been revealed to earlier generations, exegesis rather than research was the key to scholarship. A famous dictum from the Jewish *Chazal* (earlier sages) has it that 'if those who were before us were like angels, we are but men; and if those who were before us were like men, we are but asses'.

38. Consider Philipp Melanchthon's denunciation of Copernicus: 'some think it a distinguished achievement to construct such a crazy thing as that Prussian astronomer who moves the earth and fixes the sun. Verily, wise rulers should tame the unrestraint of men's minds'. Cited by Hermann Kesten, *Copernicus and his World* (New York 1945) 309. Andrew D. White (1896, vol. 1, 128) added that 'strange as it may seem, nowhere were the facts confirming the Copernican theory more carefully kept out of sight that at Wittenberg – the university of Luther and Melanchthon'. On the other hand, in Catholic France, the philosopher Petrus Ramus could be promoted on a lecture entitled 'On the errors of Aristotle' (1536) in which he proposed nothing short of a complete alternative to Aristotle's philosophical system. The Sienese Monk Bernardino Ochino (1487-1564) advocated a host of unorthodox ideas such as divorce and bigamy. Much of the most innovative scientific work between 1500 and 1700 took place in Catholic nations.

Philosophers and theologians were seen to threaten the entrenched status quo more than physicists or experimental scientists, but the separating lines between them were harder to establish than in our own time. The Brabant chemist Jan-Baptist Van Helmont had his book *De magnetica vulnerum* impounded and in 1624 the inquisition in the Spanish Netherlands began formal proceedings against him for 'heresy and impudent arrogance'. In Naples, the philosopher Giambattista della Porta who had experimented with incubators for chicken hatching was accused in 1588 by the Inquisition of being 'a sorcerer' and had to abandon his work. The great Paracelsus, admittedly an extraordinarily pugnacious person, strongly provoked the received medical wisdom of his time and had to repeatedly escape towns where he had worn out his welcome with the local authorities. The two most famous executions of intellectual innovators, Giordano Bruno and Miguel Servetus, condemned to death by the Roman inquisition and Calvin's Geneva court respectively, were of scientists who were persecuted for their religious doctrines not their natural philosophy per se.[40] By the time Galileo was summoned to Rome, the battle over geocentricity was in fact over, and to the extent that Galileo's astronomy was what got him in trouble, it was a rear-guard action. But it is telling that Copernicus delayed publishing *De Revolutionibus,* and that his editor found it necessary to add a disclaimer that his views were purely speculation. All the same, most seventeenth century intellectual innovators were fairly successful in partially separating their science from their religious philosophy. Philosophers and scientists such as Bacon, Descartes, Huygens, and of course Newton were respectful of religion and stayed away from theological controversies. The growing specialization and technical jargon of science made it increasingly difficult for authorities protecting the orthodoxy to intervene directly.

The meta-idea about the market for ideas was itself an innovation in the seventeenth century. The ideals of tolerance and persuasion by argument and evidence, in which ideas were selected freely by individuals on merits other than acceptability by the ruling orthodoxy, eventually emerged successful. It held that selection among competing theories or observations was to be determined by criteria unrelated to politics, with acceptance exclusively determined by the rhetoric of knowledge itself: logic, rigor, experimental evidence, and observation. The triumph of this model became closely associated with the

---

39. Despite the increasingly repressive regime of the counter-reformation in Italy in the second half of the seventeenth century, some of the most innovative scientists of the scientific revolution were Italians: Marcello Malpighi, Giovanni Alfonso Borelli, and Giandomenico Cassini.

40. A few others could be added to this list, such as Lucilio Vanini, executed in Toulouse in 1617 for atheism and Ferrente Pallavicino, executed in Avignon in 1642 for disrespect of the Pope.

concept of the Enlightenment. All science and knowledge were riven with politics and their separation remained an ideal that in practice was never achieved but degree is everything, and the politics of science changed considerably. What was determined in the age of Enlightenment was the principle of how scientific disputes were to be resolved when new information or insights emerged. In that regard, Lavoisier and Adam Smith were subject to the same rules. Consistency with earlier theories and respect for the knowledge of previous generations was to have little impact on selection, at least in theory.[41]

The market for ideas that emerged in the seventeenth century gradually abandoned coercion and orthodoxy in favor of methods that persuaded by other criteria. This is not to say that coercion was abandoned altogether: as late as the 1760s French *philosophes* had to worry about the consequences of their publications. Even in progressive Scotland, David Hume was denied a professorial chair because of his atheism.[42] Moreover, the growth of useful knowledge could not proceed without some notion of authority, nor was such authority altogether independent of social standing.[43] All the same, the almost absolute power with which the canons of Aristotle, Avicenna, Ptolemy, and similar classical writers who had ruled the intellectual world for centuries was broken. In the two centuries before the Industrial Revolution the selection mechanism of ideas, including both natural and political philosophy became less committed to the orthodoxy. Coercion was tried over and over again, but it was becoming increasingly ineffective in the decades before 1750. If ideas were to be contestable, this coordination failure was of crucial importance.

Why did the European marketplace for ideas become less coercive and more competitive in the centuries before the Industrial Revolution? As Elizabeth Eisenstein has stressed, the printing press was surely a major factor in the decline in access cost, but it was not enough in and of itself because presses could be controlled or even banned by powerful authorities.[44] In the Islamic world, printing was prohibited until the eighteenth century, and no books in Arabic script were printed in the Ottoman Empire before 1729. The power of

---

41. John Taylor, a teacher at one of Britain's dissenting academies, Warrington Academy, told his pupils in 1757 that 'if at any time hereafter any principle or sentiment by me taught or advanced, or by you admitted and embraced, shall upon impartial and faithful examination appear to you to be dubious or false, you either suspect or totally reject that principle or sentiment'. Cited by David Reid, For the Benefit of Knowledge: Charity, Access Costs, and Education in Pre-industrial Britain. Paper presented for the workshop on 'History, Technology, Economy' Appalachian State University, April 24, 2006 8-9.

42. Voltaire famously purchased his property in Ferney in the 1750s close enough to the Swiss border to make an escape if push came to shove, but within France's borders to escape repressive Geneva regulations on having a private theater on his estate.

43. Steven Shapin, *A Social History of Truth* (Chicago 1994).

44. Elizabeth Eisenstein, *The Printing Press as an Agent of Change* (Cambridge 1979).

authorities in charge of defending the orthodoxy was increasingly constrained by their inability to coordinate their actions over different political entities.[45] In other words, European political fragmentation created the environment in which dissident and heterodox opinions could be put forward with increasing impunity. Had a single, centralized government been in charge of defending the intellectual status quo, many of the new ideas that eventually led to the Enlightenment would have been suppressed or possibly never even proposed.[46] But Europe almost always offered havens to persecuted dissidents and heretics, and while these havens were not always the same, they could almost always be found. Most 'heretics' could survive by finding one protector or another who prevented their suppression, whether because they were genuinely persuaded or simply to spite a rival ruler. The career of Martin Luther was, of course, a classic example of this phenomenon, but many of the most influential and innovative intellectuals took advantage of what Jones has called the competitive 'States system'.[47] In different ways, Paracelsus, Comenius, Descartes, Hobbes, and Bayle, to name but a few, survived through strategic moves across national boundaries. They were able to flee persecutors, and while this imposed no-doubt considerable hardship, they survived and prospered.[48]

European intellectuals learned other methods of playing one political power against another. At times, as Galileo's story makes abundantly clear, this protection was only partial when the response of the threatened orthodoxy was particularly virulent. Yet Galileo spent the time of his trial at the home of the Tuscan ambassador, and afterwards at the home of Ascanio Piccolomini, the archbishop of Siena, one of his admirers. Galileo's plea-bargain was a compromise between fundamentalist reactionaries and his powerful supporters. In one form or another, then, many of the most influential intellectuals post 1500 relied on the fragmentation of power within Europe to thwart attempts of the orthodoxy to suppress them.[49]

---

45. Joel Mokyr, Mobility, Creativity, and Technological Development: David Hume, Immanuel Kant and the Economic Development of Europe. Paper prepared for the session on 'Creativity and the Economy', German Association of Philosophy, Berlin, Sept. 18, 2005. Forthcoming in the Kolloquiumsband of the xx. Deutschen Kongresses für Philosophie, Berlin 2006, 1131-1161.

46. This argument complements the one made by Eisenstein, *The printing press*, 398, who points out the role the printing press played in the decline of the influence of the only supranational body with the capability of coordinating the suppression of intellectual innovation, namely the Catholic Church.

47. Eric L. Jones, *The European Miracle* (Cambridge 1981) chapter 6.

48. For details, see Mokyr, Mobility.

49. Less well-known but equally telling is the tale of Tommasso Campanella, (1568-1639), an Italian monk who studied astronomy, astrology, and occult philosophy, and soon became a severe critic of the Aristotelian orthodoxy. Accused from an early age of heresy by

Only when the conservative powers were operating in a coordinated fashion (as occurred in the execution of Jan Hus) did the ruling status quo have a chance to succeed in its attempts to suppress intellectual innovation. The division among the main reactionary powers (between the Habsburgs, the Bourbons, and the Papacy) and their internal fights, and the equally serious divisions within the Protestant camp, meant that such coordination was rare.[50] Moreover, fragmentation of power was as prevalent *within* states as between them. For one thing, power was divided between central authorities, provincial estates, and local courts. In Germany and Italy, of course, this had become formalized, but in other 'states' such as the Dutch Republic, the central government had little power. Moreover, in many countries there were semi-autonomous corporations that exercised their own justice and sovereignty such as universities, boroughs, and guilds. Overlapping and poorly coordinated jurisdictions created opportunities for adept individuals to maneuver in the seams and cracks of the system and find niches from which they could operate unperturbedly. Even in political units that resembled modern nation states much of the actual administration was concentrated in the hands of local authorities (such as the JP's in England), who often had their own views.

Victories in this game were piecemeal and never final. The age of Enlightenment, too, experienced a number of cases in which judicious flights to foreign countries were necessary to avoid the consequences of the displeasures of the orthodoxy.[51] By that time, however, suppression was more about face-saving than any realistic hope that Enlightenment ideas could be suppressed. Rousseau, for instance, could live out his last decade in France despite the storm created by his work and the radical Wilkes returned to Britain and eventually became Lord Mayor of London.

---

the Inquisition, his ability to play one power against another in fragmented Italy ran out when he was sentenced to life imprisonment in 1599 (for anti-Spanish activity rather than for heresy) and spent twenty seven years in a Neapolitan jail. His conditions there, however, were sufficiently benign that he could write seven books as well as a pamphlet defending Galileo during his first trial in 1616. He could accomplish this in part because the Emperor Rudolf, Duke Maximilian of Bavaria, and other Catholic notables were exerting influence to protect him. In the end, he was released from jail thanks to the intervention of Pope Urban VIII.

50. Cardinal Reginald Pole, the leader of the Catholic reaction in England, was denounced as a heretic by the equally reactionary Pope Paul IV.

51. While suppression of new ideas had become decidedly less virulent, it flared up in France in the late 1750s after the publication of Claude-Adrien Helvétius's *De l'Esprit* in 1758. It was condemned by the Sorbonne and burned in public; Helvétius found himself in England and later on in Potsdam. A few years later, Rousseau's *Émile* created a scandal, and he, too, had to flee. John Wilkes, the English radical, fled to Paris in 1764 to escape his trial for seditious libel.

A freer market for ideas can thus be seen as the outcome of a classic political coordination failure between the powers of reaction in Europe. There was strong resistance to radical new ideas, and resentment of the often eccentric and erratic behavior of the people who generated them. But the conservative powers did not fight innovation all at the same time, nor did they always pick on the same issues. As a result, the suppression of novel ideas lost steam, and by the mid-eighteenth century pursued in only a half-hearted way. Even some of the more conservative rulers of Europe found themselves pushed toward a policy of 'if you cannot beat them, join them' and co-opted many of the ideas of the Enlightenment, creating the oxymoronic 'enlightened despots'.[52] As a mechanism of epistemic selection, forcible conformism and coercion lost power in Europe. Their replacement by other tools of rhetoric was not always and everywhere an improvement, and politics remained central to the intellectual evolution of the Continent. However, the incentive structure facing would-be innovators was changed due to the reduction of the likelihood of serious persecution.

The net result of this change was double-barreled. For one thing, the market for ideas increasingly selected those notions that seemed by the criteria of the time to be consistent with the evidence. Needless to say, there is no presumption that these ideas were in some sense 'correct'. But the Copernican view of the heliocentric universe, the Newtonian analysis of celestial dynamics, and Torricelli's hypothesis of the existence of an atmosphere (to pick just a few examples) were tested, examined, and found to be consistent with the rhetorical conventions and experimental capabilities of the time. So was Georg Stahl's phlogiston theory. Later in the eighteenth century, when phlogiston chemistry was challenged by Lavoisier and his followers, the matter was decided on the experimental evidence despite stubborn resistance.

Moreover, a more open-minded selection system affected incentives. The improving efficiency of the market for ideas encouraged new entrants both on the extensive and the intensive margins. As the expected risks of persecution declined, more and more original and talented people chose careers in intellectual pursuits, and those who did may have ventured into more innovative areas. They were still constrained by the moral conventions of the times, but these could be readily circumvented.[53] By the eighteenth century, the study of

52. For a recent re-assessment of the concept, see the essays in: H.M. Scott (ed.), *Enlightened Absolutism: Reform and Reformers in Later Eighteenth Century Europe* (Houndmills 1990).
53. Thus Anthonie van Leeuwenhoeck used his microscope to identify spermatozoa in 1677, but prudently added that the specimen he chose was the result of the excess bestowed upon him by Nature in his conjugal relations with his wife Cornelia and not obtained by any 'sinful contrivance'. Matthew Cobb, *Generation: Seventeenth Century Scientists who unravelled the Secrets of Sex, Life, and Growth* (New York 2006) 202-203.

nature had become distinctly less hazardous even for people who tried to upset the applecart. As the generation of intellectual innovations became more attractive, it brought in more people trying their hand at suggesting new ideas. Most of these ideas were rejected, but with the selection system firmly in place, its long term effect on technological development seems certain.

Diffusion

In addition to costs, incentives were affected by the expected benefits of intellectual innovators. These benefits are more complex than they are in the market for commodities. Knowledge is non-rivalrous, and as Dasgupta and David have noted, requires an institutional set-up unlike any other market because the market for ideas in many ways resembles an open-source technology.[54] Open science, as many scholars have stressed, was the key to the rapid changes in the market for ideas because its very purpose was to disseminate new ideas and offer them to the marketplace. The mechanics of open science, in which important new ideas were exposed to the critical minds of colleagues, was based on the principle that academic contributions were rewarded with priority credit, not profit. New ideas were published and placed in the public realm by their creators to establish priority. Priority is a property right, even if it does not attempt exclusivity.[55]

To draw the full benefits from a contribution to knowledge, a large audience was optimal, because the cost of making a discovery or proving a theorem is all upfront. The costs were almost entirely fixed, and the marginal costs of dissemination were negligible. Hence, in a highly fragmented world, in which the constituents in the market for ideas were local, the likely payoff of coming up with a new idea would be, all other things equal, low relative to the cost. Precisely for that reason, a fragmented states system is never a sufficient condition for a sudden flourishing in the market for ideas. Instead, what is needed is a wide market, in which demand for ideas reaches beyond the narrow boundaries of one's country of origin. Such markets could ensure a more intense competition and a greater and more diverse pool of talent from which new ideas could be drawn. Moreover, in an integrated world, students were free to

---

54. Partha Dasgupta and Paul A. David, 'Toward a New Economics of Science', *Research Policy* Vol. 23, 1994, 487-521.

55. The first major priority fights between scientists date to the seventeenth century, the most famous of which are the arguments between Newton and Leibniz (about calculus) and Newton and Hooke (about the inverse-square force law). No less fierce was the battle between two Dutchmen, Jan Swammerdam and Reinier de Graaf on certain aspects of female reproduction.

pick and choose universities, mentors, as well as diversify their intellectual portfolios. In a medieval world of expensive books and personal teaching, fragmentation could be the archenemy of intellectual diffusion. In Europe in the seventeenth and eighteenth centuries the intellectual community was far less fragmented than the political structure, and this peculiar condition holds the key to subsequent intellectual developments.

What is striking about early modern Europe, then, is that it was able to combine the best of fragmentation and consolidation. Political fragmentation was combined with a unified market for ideas in which neither language differences nor political boundaries (which often did not coincide) stopped ideas from spreading through the Continent. What emerged in early modern Europe was a transnational community that defined the extent of the market for ideas. The idea of a 'Republic of Letters,' or a *Respublica Litteraria*, goes back to the late Middle Ages, and by the eighteenth century had extended to mechanical and technical knowledge.[56] During the Renaissance, Europe witnessed the creation of a network of scholars and engineers that transcended political and ethnic boundaries.[57] This entity was well established at the start of the Enlightenment movement. It is easy to mistake a sense of belonging to the 'Republic of Letters' as a form of personal loyalty to a transnational entity, but for many if not most scientists loyalty to King or Republic did not usually conflict with their need for a large and international audience. The Republic of Letters, in practical terms, was a marketplace, not an identity. On the matter of identity, a great deal of ambiguity remained, that would come to haunt European scientists when national loyalties clashed with the ideal that the 'sciences were never at war' as Lavoisier once expressed it, perhaps naively. Its members shared a belief in the principles of 'open science,' and shared, to a large extent, the rhetorical conventions by which propositions should be accepted or rejected and the rules and forms of the communications of intellectuals. Hence, in the end, on many of the most fiercely debated issues of the day, some measure of consensus was reached – a concept not too far from the notion of a market equilibrium.[58] Unlike medieval Europe, where the marketplace for ideas was largely determined by a few large monopsonistic players, the Republic of Letters was competitive, welcomed new entries, and relatively little concerned about authority.

---

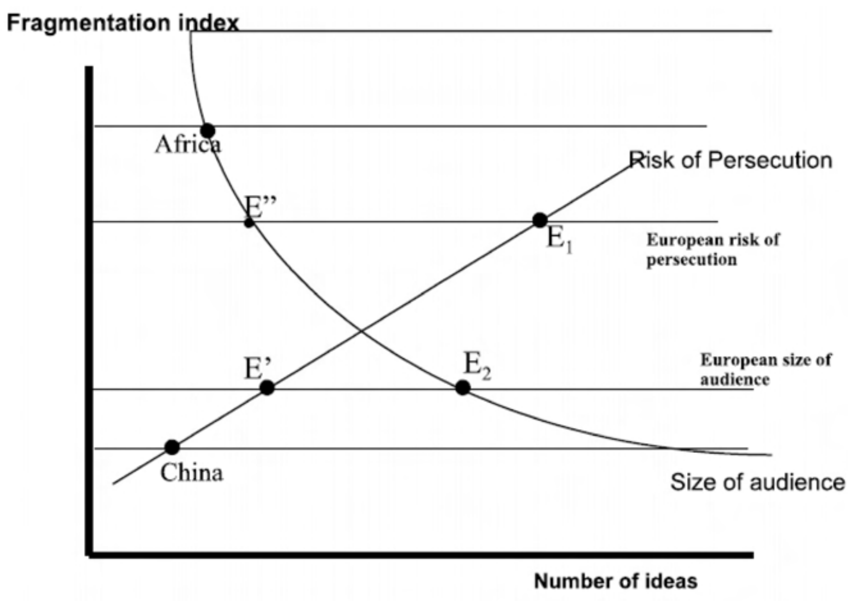
56. Lorraine Daston, 'The Ideal and Reality of the Republic of Letters in the Enlightenment', *Science in Context* Vol. 4 1991 (2) 367-386; Robert Darnton, 'The Unity of Europe', in: *George Washington's False Teeth* (New York 2003).

57. Collins, *The Sociology of Philosophies*, 523-569.

58. An important example is the late seventeenth century dispute between Newtonians and Cartesians on the shape of the earth, Newtonian theory suggesting an oblate (flattened at the poles) shape as opposed to the prolate (oblong) theory of the Cartesians. The great

This situation is described in fig. 1. The upward sloping solid line measures the fact that as fragmentation increases, the effectiveness of persecution declines and thus the number of ideas increases; on the other hand, as fragmentation increases, the audience shrinks, and thus the other solid curve is downward-sloping. In a world such as denoted by the lower broken line, the actual level of ideas would be min(E', E_2, that is, E'). Hence a high-fragmentation world ('Africa' – purely in a metaphoric sense), would be at the point so denoted, whereas a single Empire such as 'China' would be at an equally low level of ideas. Had Europe not experienced a disconnect between the size of the political unit and the intellectual community, it would have been at something like E'. However, as things turned out to be, they found themselves at a point such as E_2 or E_1 (whichever of the two is lower), at which the level of ideas will be higher than at either E' or E".

Figure 1 *The market for ideas and the level of fragmentation*



mathematician and Enlightenment genius Pierre Louis Maupertuis and his mathematician colleague Alexis-Claude Clairaut went in 1736 to Lapland to make the appropriate measurements, finding the evidence in favor of Newton's theory. Some minor anomalies remained, and new mathematical and geodesic tools were applied to the question until the matter of the degree of flattening was settled by the early nineteenth century.

The diffusion of new ideas and market efficiency also depended on the level of transactions costs, and the transactions cost in the market for ideas were primarily what I have called access costs. They are the costs that a person who acquires a piece of knowledge has to pay even if the payments do not necessarily accrue to the person who created the idea. Access costs consisted of physical costs, affected by such advances as the printing press, cheaper paper, postal services, cheaper personal transportation, and of institutional changes such as the development of schools and universities, and the establishment of academies and scientific societies. Open science was central to the generation and the diffusion of new useful knowledge. Potentially productive ideas were first made accessible to other intellectuals, who could peer-review and criticize them. For non-experts, this set-up, at least in theory, increased reliability, so that people in the fields and the workshops might be more likely to make use of them. Yet in reality, for many decades, this idea remained more wishful thinking than reality.[59]

In sum, the transnational community of scholars operated with increased effectiveness in the sixteenth and seventeenth centuries. Its norms and rules increasingly favored competitive behavior in the market. New ideas, findings, and theories were placed in the public realm, where they were tested and judged by peers from different nations. Much like our own globalized world, the community of scholars created a winner-take-all tournament, in which a few international superstars emerged, setting a model for hopeful followers. Such superstars in many ways personified the way in which Europe's fragmented-yet-unified intellectual community worked. The two great academies founded in the 1660s, the Royal Society and the Académie Royale, were soon in a position to pick winners in this tournament.[60] Among those were the Italian Giandomenico Cassini, invited by Colbert to head the royal observatory in 1668 and the Dutchman Christiaan Huygens who became a paid member in 1668. Marcello Malpighi was elected to the Royal Society and published most

---

59. As late as 1799, one of the archtypical Enlightenment scientists, Count Rumford, sighed that 'there are no two classes of men in society that are more distinct, or that are more separated from each other by a more marked line, than philosophers and those who are engaged in arts and manufactures' and that this prevented 'all connection and intercourse between them'. See William Thomson, count Rumford, *The Compete Works of Count Rumford* (London 1876) 743-745. By that time, surely, his statement was no longer wholly valid, and indeed was becoming increasingly less so. Priestley felt that 'the politeness of the times has brought the learned and the unlearned into more familiar intercourse than they had before'. Joseph Priestley, *An Essay on a Course of Liberal Education for Civil and Active Life* (London 1768) 22.

60. For a more detailed analysis of these tournaments as a common agency problem, see Paul A. David, Patronage, Reputation, and Common Agency Contracting in the Scientific Revolution (Unpublished manuscript, Stanford University, Aug. 2004).

of his important work in its *Transactions*.[61] The greatest 'winner' in this game was doubtlessly Newton, whose ideas triumphed in the eighteenth century international market and who became a global superstar.[62] But the careers of other leading scholars also indicate this cosmopolitan nature of European intellectuals.[63]

Important works were at first still written in the lingua franca, Latin, but as the vernacular gradually became more and more popular as the form of writing, they were translated. Such translations were one of the most significant signs of the emergence of the international market for ideas. So were the correspondence networks between citizens of different countries. Most importantly, people travelled, notwithstanding the difficult circumstances.[64] Famous scientists were, as a rule, far more mobile than laborers or peasants – as were well-known composers, painters, and performance artists. As a result, scientific reputations were far more valuable and worth investing in. Europe's system, to put it crudely, got the best of two worlds. It had all the advantages of a unified market, without the costs that accompanied the centralization of power.

The significance of the market for ideas

The forces in the market for ideas, like in any other market, reflect both supply and demand. The demand for ideas on how economic life should be managed and controlled reflected, up to a point, the changing interests of a new urban-commercial class, that had grown substantially in the sixteenth and seventeenth centuries and was interested in increasing economic openness, monetary stability, more secure property rights, enforceable contracts, a state that solved obvious problems of coordination, and fiscal commitments that were subject to consent. To that list we should add the 'demand' for new technology that would replace labor, which was particularly costly in the United Provinces and Britain. It has been argued by Allen that the high cost of labor relative to that of energy might have been instrumental in focusing the minds of British

---

61. The Society chose to prefer Malpighi's work over that of his Dutch competitor, Jan Swammerdam. See Catherine Wilson, *The Invisible World: Early Modern Philosophy and the Invention of the Microscope* (Princeton 1995) 94-98, 189.

62. David, Patronage, Reputation.

63. The great Moravian intellectual Jan Comenius, fleeing war and persecution, found himself in London, Stockholm, and Amsterdam among other places and was offered the presidency of the newly-founded Harvard College. Descartes, Huygens, Leibniz, Euler, and many others established international reputations and were offered cushy patronage jobs by various academies, courts, and universities.

64. Mokyr, Mobility.

inventors on ways to substitute fuel for human labor.[65] It may therefore be no accident that steam power was born in Britain. Yet it is hard to see how such growing sentiments by themselves would automatically trigger a process of economic growth based on technological progress without accompanying changes on the supply side. In order for the economic advances of the age of geographical exploration and growing commercial sophistication of the sixteenth century to turn into the Industrial Revolution, something else had to occur in between.

That event was the Enlightenment. In terms of the market for ideas, one can see the Enlightenment in two ways. It can be regarded, first, as itself a set of ideas that ended up triumphing over competitors. Some of these ideas were in the realm of science, others in that of political philosophy, metaphysics, and economics. We cannot be fully sure why these ideas triumphed over opposing ideas such as religious fanaticism and mercantilist notions that wealth-creation and preservation was always and everywhere dependent on political power and military muscle. We can, however, establish one important factor in determining that outcome: Europe had a successful Enlightenment whereas other parts of the world did not because it already had a market for ideas in which ideas could compete and win on their own merit.

Secondly, the Enlightenment can and should also be seen as a widening of support for the belief in a free market for ideas *itself*, a market that should be supported by certain institutions and submit to certain rules. The success of the Enlightenment – in both senses – itself was far from pre-ordained or even probable. In fact, it failed in parts of Europe. Similar phenomena outside the West, such as the *Kaozheng* ('school of evidentiary and pragmatic research') movement in seventeenth century China, made little impact on the economy.[66]

Not *everything* about the Enlightenment mattered to the economy. Moral and political issues, human rights, equality and justice, and the growth of anticlericalism and secularism were perhaps not of immediate significance to economic growth. The belief in 'reason' and 'liberty' as such was not enough to

---

65. Robert C. Allen, The British Industrial Revolution in Global Perspective: How Commerce Created the Industrial Revolution and Modern Economic growth (Unpublished, Nuffield College, Oxford 2006).

66. An instructive example is the career of Chu Shun-shui, one of the Chinese intellectuals who can be compared with his European counterparts. His approach to wisdom was pragmatic: he felt it should be judged on whether it was of use to society. While not quite Baconian in his approach (his interests were mostly rituals and public virtues), he was an unusually independent thinker. His knowledge was quite broad and extended to fields of practical knowledge such as architecture and crafts. Fleeing from China (he had remained a supporter of the Ming dynasty, overthrown in 1644) first to Annam (Vietnam) and then to Japan he encountered many hardships in both places as the East was clearly not accustomed to itinerant intellectuals. He was twice denied permission to remain in Japan and was imgenerate long-term economic growth. But what mattered here were two basic ideas, without which the Industrial Revolution would not have turned into long-run growth.[67]

One was the belief that the discoveries of 'natural philosophy' could and would lead to material progress, as Bacon had foreseen. Economic historians and historians of technology were delighted to point out that the Industrial Revolution owed little to science, and that many of the central inventions of the Industrial Revolution did not require more science than what Galileo – some even say Archimedes – knew. Recent research has reminded us of the importance of artisanal inventions during the eighteenth century and before.[68] My emphasis on the Enlightenment as the critical historical background to the economic transformation of the West should not be seen as an attempt to point to science as the sole or even the central causal factor.[69] The event was too momentous to have a single cause. An argument for the Enlightenment is less an argument for the importance of science vs. artisans in the Industrial Revolution as one that emphasizes the importance of cooperation and complementarity between them. Without the capabilities of dexterous and skilled artisans to build equipment and produce materials according to specifications, to operate and maintain advanced tools and machines, the most revolutionary techniques would remain in the blueprint stage. Artisans were people who actually made things that they did not usually design, not once but over and

prisoned in Annam. In the end, he was allowed to stay in Japan, where he had quite a following and eventually became advisor and mentor to the daimyo Mitsukuni. Chu Shunshui, in Julia Ching's words, was hardly a purely abstract philosopher, but 'the investigation of things referred to less to the metaphysical understanding of principle of material forces, and more to coping with concrete situations. At the same time, the extension of knowledge applied not only to knowledge of the Confucian classics, but also to all that is useful in life'. Yet Chu's work remained unknown in China and his work was rediscovered by a much later generation of Chinese refugees who fled to Japan after the Hundred Days Reform in 1898. See Julia Ching, 'The Practical Learning of Chu Shun-shui, 1600-1682', in: W. Theodore de Bary and Irene Bloom (eds.), *Principle and Practicality: Essays in Neo-Confucianism and Practical Learning* (New York 1979) 189-229.

67. For more details, see Joel Mokyr, 'The Great Synergy: the European Enlightenment as a factor in Modern Economic Growth', in: Wilfred Dolfsma and Luc Soete (eds.), *Understanding the Dynamics of a Knowledge Economy* (Cheltenham 2006) 7-41.

68. For recent contributions see Liliane Hilaire-Pérez and Catherine Verna, 'Dissemination of Technical Knowledge in the Middle Ages and Early Modern Era', *Technology and Culture,* Vol. 47 (July) 2006, 536-565; Liliane Hilaire-Pérez, 'Technology as a public culture in the XVIIIth century: the artisans' legacy', *History of Science,* 2007 Vol. XLV, in press; Maxine Berg, 'The Genesis of "Useful Knowledge"', *History of Science,* 2007 Vol. XLV, in press.

69. For recent important contributions that emphasize the role of science, see Lipsey, Carlaw and Bekar, *Economic Transformations*; Margaret C. Jacob and Larry Stewart, *Practical Matter. Newton's Science in the Service of Industry and Empire, 1687-1851* (Cambridge (MA) 2006).

over. When they saw a way of making things cheaper, faster, or more reliable, they would do so, and the knowledge would often found ways to spread to colleagues, neighbors, and eventually to the industry as a whole.[70]

Yet artisans, unless they were unusually gifted and well-educated, were good at making incremental improvements to existing processes, not in expanding the epistemic base of the techniques they used or applying state of the art knowledge to their craft. Artisans were also not well-positioned to rely on the two processes of analogy and recombination, in which technology is improved by adopting or imitating tricks and gimmicks from other, seemingly unrelated, activities. If all that were needed for the Industrial Revolution had been imaginative and skilled artisans, it could have occurred centuries earlier. Highly dexterous and talented artisans, after all, had been around for centuries, and relying on their innovativeness without the infusion of more formalized and systematic useful knowledge for an explanation of the Industrial Revolution would make it difficult to understand not only why things moved so rapidly in the late eighteenth century but why they did not fizzle out subsequently as they had in the past. In the years after 1815, the economic sea-change we call the Industrial Revolution would surely have lost steam and eventually settled down on the dominant designs of the 1780s and 1790s had it not been for the constant infusion of inputs from scientific discoveries and methods into the techniques in use, and the gradual widening of the epistemic base of both existing and new techniques.

The second Enlightenment idea that mattered to economic growth in the long run, and which is not directly related to technology as such, was a change in the mercantilist world-view that saw the economic process as a zero-sum game. In a mercantilist model, the gains of one side were counterbalanced by the losses of the other. The economic process was regarded purely as a tournament, in which individuals, groups, regions, and nations struggled over what they believed was a fixed pie. In that kind of world, redistribution and rent-seeking were more important than efficiency and growth. Enlightenment political economy first modified and then abandoned this view altogether. Economics shows that efforts that redistribute wealth rather than create it actually reduce the overall pie because they distort incentives and misallocate resources.[71] While the finer points of this insight were, of course, not wholly realized, Enlightenment writers intuitively recognized the costs of rent-seeking and launched an all-out campaign against institutions that supported it, from tariffs and bounties that

---

70. Carlo Marco Belfanti, 'Guilds, Patents, and the Circulation of Technical Knowledge', *Technology and Culture*, 45 (July 2004) 569-89.

71. William J. Baumol, *Entrepreneurship. Management, and the Structure of Payoffs* (Cambridge (MA) 1993); William J. Baumol, *The Free-Market Innovation Machine: Analyzing the Growth Miracle of Capitalism* (Princeton 2002).

meddled with free international and domestic trade to limitations on occupational choice, the mobility of labor and capital, barriers to entry, and the myriad of *privilèges* and exclusionary rights enjoyed by assorted groups and individuals. A corollary of this insight was to challenge the widely-held mercantilist notion of a necessary link between the accumulation and protection of wealth and political or military power. Such notions were, as was realized by enlightenment thinkers, self-fulfilling. In much of post-Napoleonic Europe, when modern economic growth emerged in earnest, economic institutions and technological progress were conditioned on the triumphs of the Enlightenment.[72]

The dual ideas of growth through technological progress and institutional reform, then, were the elements of the Enlightenment that brought about modern economic growth. What is remarkable is not that these notions emerged at all, since the supply side of the market for ideas produces all kind of intellectual innovations, but rather that they were actually triumphant. European institutions changed in part because those who wrote the rules of the economic games were persuaded that Enlightened views were correct. How and why this happened remains the key to understanding modern European History. It is surely the case, as John Stuart Mill wrote in an often-quoted line, that a good cause seldom triumphs unless someone's interest is bound up with it. Commercial capitalism, at times, found enlightened ideas congenial to its interests. But it would be unwarranted to write the historical development of ideology as a linear model in which economic interests uniquely determined ideology. After all, there were conflicting economic interests bound up with different causes. The *ancien régime* defended itself with vigor, as did many economic interests and entrenched distributional coalitions, and outcomes were everywhere contested and contingent. Why did the Enlightenment ideology win?

Simple deterministic arguments pointing to economic interests will not do. It may seem plausible that the concepts of rationality and liberty, the mainstays of Enlightenment thought, would be more agreeable to a commercial and industrial urban class we associate with eighteenth-century economic development. But in fact many of these very interests had traditionally supported mercantilist regulation and state control. Moreover, the marketplace for ideas did not operate purely on persuasion and rhetoric, and force as a means of persuasion did not disappear with the Enlightenment. One of the supreme ironies in European history is that the triumph of the Enlightenment relied a great deal more on coercion than the *philosophes* would have been comfortable with. The institutions and conventions of the *ancien régime* forcefully resisted the

---

72. Guilds and monopolies had been weakened, internal tariffs eliminated, and price control of wheat abolished. Anachronistic legislation such as Navigation Acts, Bubble Acts, and laws limiting labor mobility and occupational choice were disappearing in the West. Free trade was slow in fully establishing itself, but from the 1820s on it was clearly on the rise.

imposition of new rules and techniques, and coercion was an important weapon in defending their turf, and the proponents of Enlightenment ideas responded in kind. The radical changes in the institutions of the European Continent, inspired by the Enlightenment, were imposed and enforced by the Guillotines of the National Convention and the bayonets of Napoleon's *batallions*. In Britain, the events of the French Revolution triggered a conservative reaction that seriously retarded the process of reform. History is rarely linear in this regard; it is full of delays and lags that are not always easy to explain. The real economic effect of the Enlightenment ideas took place only after 1815 – to coincide with the beginning of sustained economic growth through much of the Continent.

Another reason that the triumph occurred, as Peter Gay has insisted, was that many of its proponents were political insiders and were closer to the establishment than they would care to admit. Many of the leading intellectuals of the age of Enlightenment were celebrities in their time, and long before the French Revolution, many rulers, appreciating their intellectual gifts, tried to co-opt them, invited them to their courts, and consulted them.[73] A further reason that the Enlightenment *philosophes* won out was that they were talented, learned, and articulate and, on balance, more persuasive than their opponents. The writings of Locke, Voltaire, Diderot, Hume, and Smith, to name just a few, were effective because they were erudite, logical, and met the rhetorical standards of the time. The impact of the work of Adam Smith on policy makers in Britain and abroad was amplified through its popularization by his followers such as Dugald Stewart and Jean-Baptiste Say.[74] Supporting the more famous leaders, there was a considerable chorus of scientists, political economists, and other writers stressing 'useful knowledge' and economic liberty. Their cumulative impact on the new institutional and scientific ideology cannot be quantified, but without it, economic growth may have been significantly slower and may have ground to a halt, as it had done during previous efflorescences in the pre-1750 past.

---

73. Peter Gay, *The Enlightenment: an Interpretation. The Rise of Modern Paganism* (New York 1966).

74. Two years after Smith's death, Pitt referred in the House of Commons to 'the writings of an author of our own times, now unfortunately no more, (I mean the author of a celebrated treatise on the Wealth of Nations) whose extensive knowledge of detail, and depth of philosophical research, will, I believe, furnish the best solution to every question connected with the history of commerce, or with the systems of political economy'. In: William Pitt, *Speeches of the Right Honourable William Pitt in the House of Commons* (London: printed for Longman, Hurst, Rees, and Orme, 1808) Vol. 1, 357-9. The chief clerk of the committee of Trade, George Shelburne, and his colleague Charles Jenkinson (later Lord Liverpool and father of the PM) were also deeply influenced by Smith's nuanced but clear-cut liberal ideas, though they tried to combine them with the British national interests. See John E. Crowley, 'Neo-mercantilism and the Wealth of Nations: British Commercial Policy after the American Revolution', *The Historical Journal*, Vol. 33, 1990 No. 2 (June) 339-60.

A number of reforms in the eighteenth century that preceded the French Revolution were inspired by the insights of the movement, some of them by the enlightened monarchs and others by reform-minded politicians such as Turgot, whose term in government lasted less than two years.[75] The biggest triumph of the Enlightenment movement was clearly the establishment of a regime in the United States based on its principles. Although the success of these pre-revolutionary Enlightenment reformers in Europe was spotty, because they depended mostly on the cooperation of autocratic rulers and were resisted by powerful authorities, they can be viewed as precursors to the more fundamental reforms introduced by revolutionary authorities after 1790.

All the same, it is important to stress that when historical change depends on the market for ideas, the contingency of the outcome is reinforced by the indeterminacy of the decisions of the market for ideas.[76] Certainly, in the 1780s, the prospects for an age of relatively free market economies and a curtailment of rent-seeking activities on the Continent looked anything but inevitable. Moreover, the clash between the Enlightenment and the *ancien régime*s produced unintended consequences, such as a strong conservative backlash and repressive regime in Britain in the 1790s, and a military dictatorship on the Continent. While these effects were eventually reversed, there was nothing inexorable about the outcome.

The late seventeenth century was the age in which many of the components of the Enlightenment were established: the ideas of tolerance and economic liberty were taking root, and the Baconian program crystallized into such institutions as the Royal Society and other scientific and learned societies all over

75. Other examples can readily be found: the Austrians Joseph von Sonnenfels (1732-1817), the first professor of Political Economy at the University of Vienna, who influenced public policy under Maria Theresa (curtailing the power of the guilds and reforming the judiciary), and Karl von Zinzendorf, who had come under the influence of radicals in Milan and physiocrats in Paris. In Milan, the Supreme Economic Council set up in 1765 to reform economic and social policy counted such Enlightenment heavyweights as Cesare Beccaria, the brothers Alessandro and Pietro Verri. In Denmark, the German physician Johann Friedrich Struensee was an 'enlightened reformer' who lasted for only a few years before his enemies got the better of him, though in 1784 another enlightened German named Andreas Peter Bernstorff was able to introduce many important reforms. In Spain, the Campomanes reforms under Carlos III attempted a similar set of policies. H.M. Scott (ed.), *Enlightened Absolutism*, 34-35 points out that many of the reforms took place in territories that had been recently acquired (e.g., Corsica and Lorraine in France) and where government enjoyed a freedom of action they never had in their core lands, where established elites and traditional privileges could display powerful resistance.

76. In 1784, Kant famously reflected that the 'Age of Enlightenment' in which he lived was not yet 'an enlightened age'. Peter Gay assesses that this distinction was penetrating and important, because even late in the eighteenth century the *philosophes* had ample reason for uncertainty and occasional gloom. Peter Gay, *The Enlightenment*, 20.

Europe. There was a rather long pause in progress in the first half of the eighteenth century when both population and economic growth were slow. The Industrial Revolution, when it happened, did not dramatically affect rates of economic growth right away, nor did it on the whole constitute a major application of the emerging body of propositional knowledge to the economy. Instead, it demonstrated in a number of instances what this knowledge could do, how engineering and ingenuity could solve problems, that at times consultation with natural philosophers could yield good results, and that, with luck, these activities could help one make money. Institutions and an economic environment friendly to innovation could produce the incentives in which existing knowledge could be applied fruitfully and new useful knowledge was likely to be generated. In terms of sustained growth, what was needed were incentives for original and creative minds to propagate new ideas and knowledge, and for these to catch on and be put to work. In this interpretation, the Industrial Revolution was neither the direct consequence of the Scientific Revolution nor itself a period of rapid economic growth. Instead, it was another stage in the long chain of changes in the market for ideas that eventually came to significantly affect economic realities.

About the author

Joel Mokyr is the Robert H. Strotz Professor of Arts and Sciences and Professor of Economics and History at Northwestern University and Sackler Professor (by special appointment) at the Eitan Berglas School of Economics at the University of Tel Aviv. He specializes in economic history and the economics of technological change and population change. He is the author of *Why Ireland Starved: An Analytical and Quantitative Study of the Irish Economy*, *The Lever of Riches: Technological Creativity and Economic Progress*, *The British Industrial Revolution: An Economic Perspective* and his most recent *The Gifts of Athena: Historical Origins of the Knowledge Economy*. He is currently working on a new book, *The Enlightened Economy* to be published by Yale University Press and Penguin in 2007. He has authored over 70 articles and books in his field. He has served as the senior editor of the *Journal of Economic History* from 1994 to 1998, and is the editor in chief of the *Oxford Encyclopedia of Economic History* (published in July 2003) and the Princeton University Press *Economic History of the Western World*. He served as President of the Economic History Association 2003-04, and is a director of the National Bureau of Economic Research and a member of its executive committee. He served as chair of the Economics Department at Northwestern University between 1998 and 2001 and was a fellow at the Center for Advanced Studies in the Behavioral Sciences at Stanford between Sept. 2001 and June 2002.

E-mail: j-mokyr@northwestern.edu