The Market for Ideas and the Origins of Economic Growth in Eighteenth Century Europe

Joel Mokyr
Depts. of Economics and History
Northwestern University
Berglas School of Economics
Tel Aviv University
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Two statements summarize much of the conventional wisdom about the historical experience of 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 sense, is about new ideas and the growth of useful knowledge. 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.

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." Most other economists are uncomfortable with the idea, ironically enough agreeing with Marx that ideas were a superstructure determined by deeper economic forces, or as Marx himself famously put it in his *Critique of Political Economy,* "it is not the consciousness of men that determines their being, but, on the contrary, their social being that determines their consciousness." Modern economists have differed on the matter as well. 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" (Ekelund and Tollison, 1997, pp. 17-18).

Paul Samuelson, on the other hand felt more like Keynes in his widely-cited comment that "let those who will write the nation's laws if I can write its textbooks." In the historical experience of European economic development, the two 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 analyzing it.

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 existence of a market for ideas depends 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 ideas were to be created. Only societies that had lifted themselves beyond bare agricultural subsistence could afford the leisure to create learning. Learning by itself was insufficient, however. What was needed was for this learning to transform itself into useful knowledge that could be applied to new techniques. Any such feedback was historically contingent. Learning could be utterly sterile economically, and in many societies it took the form of exegesis, mystical and occult-like studies, and the endless poring over and rehashing of theological and abstract issues.

More was needed, however, than an applied and practical research focus. For useful knowledge to have an economic impact through innovation, a certain institutional structure was needed that not only created such knowledge, but also placed it at the disposal of those who could use it best. For knowledge to be technologically useful and to affect material welfare, it had to be engaged in expanding what I have called the epistemic base of technology, that is, the understanding of the natural laws and regularities that make something work. For sustained growth to occur, it was not sufficient to come up with new tricks and artifacts evolving through trial and error. Although inventions could be and were made without anyone having much of a clue of why and how they worked, these techniques typically crystallized soon and did not generate anything like long-term advances. It was harder to adapt them to new circumstances. Intellectuals had to be concerned with natural phenomena and regularities that underlay the techniques in use, to set up the right kind of questions, and not to rule out any areas of investigation. In other words, growth required an environment that created knowledge *of the right kind*. This environment can be regarded as part of a "marketplace for ideas" in which new ideas compete with old ones to be somehow "selected." This market is more of a Schumpeterian construct in which the competition is less between identical products than between old and new ideas.[1] What is true for new technology is true for all ideas, not just technological ones.

The point I want to make here is quite simple. 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 market for ideas in which intellectual innovators proposed theories, facts, observations, and interpretations of the world around them. Out of that market emerged victorious a complex but reasonably coherent set of ideas that we term "the Enlightenment." 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* 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 has hitherto received little attention.

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[1]As he noted (1950, p. 84) 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."

To be more precise, a market that generates technologically-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. 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. Such analogies are, perhaps, a bit stretched. The market for knowledge is in many critical aspects quite different from other markets. Yet in terms of bringing together various elements that explain long-term historical change, the notion of a market is helpful. Much of my talk today will be dedicated to this issue, because it is my hypothesis that 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.

The two centuries before the Industrial Revolution 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 in the end became the dominant element in productivity growth. This was a slow and drawn-out process, but it was also relentless and cumulative, and by the early nineteenth century it was sufficiently powerful for technological innovation to be turned from being a sporadic exception 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 economc 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 only be observed indirectly but that in the long run were decisive to the fate of the economy.

Agenda

Terms such as “research” or “development” are a bit anachronistic as far as the seventeenth century is concerned, but there is no doubt that there was considerable progress in what we would call today science and what contemporaries termed “natural philosophy.” Whether the advances in physics, chemistry, astronomy, and mathematics between Galileo and Leibniz deserve the term “scientific revolution” or not remains to in dispute. 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” — either morally, socially, or, increasingly, materially. Society was *improvable* through knowledge, and the purpose of study and experiment 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.[2] Many, if not most of the natural philosophers of the age thought much like Bacon and acknowledged their intellectual debt to his ideas.

Even if the knowledge accumulated by natural philosophers could rarely be applied directly in the eighteenth century, these scholars used their rigor and training to attack practical problems. Among them were the greatest minds of the scientific enlightenment.[3] Rather than just gazing at the

[2]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.

[3] 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. 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 make better and cheaper steel, how to determine longitude at sea, how to light homes and cities safer and better, how to prevent smallpox, and similar questions.

stars, dabbling in the "occult," or making metaphysical points about the wisdom of the creator, a new, practical, and more down-to-earth natural philosophy emerged in the eighteenth century, produced by people who felt that the world could be improved by their knowledge. This knowledge was to be applied increasingly to the mundane world of crafts and farming, and in the late seventeenth century intellectuals were attracted to technology and its mysteries more than ever before, as embodied in the early work of the Royal Society.[4]

It is remarkable that belief in this mission remained indefatigable in the face of continuous frustration and disappointment (although the Royal Society itself lost its fascination with technology). 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" (Donovan, 1975, p. 84). 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 leading expert on eighteenth-century chemistry, "more in the nature of a promissory note than a cashed-in achievement" (Golinski, 1992, p. 29). 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 (Keyser, 1990, p. 222). 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

[4]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 (Lyons, 1944, pp. 41-42).

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.[5] Another striking example is electricity. The eighteenth-century natural philosophers were fascinated by this strange force, and believed that once tamed, it held great promise. While 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 this mysterious phenomenon, practical applications had to await the breakthroughs of Oersted, Faraday, and Ampère in the first half of the nineteenth century. The one exception was, of course, 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 on unsuccessful research, constrained by the limitations of a world in which engineers, farmers, industrialists, and mine-operators knew preciously little about the fundamental physical rules that governed the techniques they used. These techniques had emerged slowly 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 enormously from field to field. When techniques are not based on an 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

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[5]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.

search for perpetuum mobile engines continued until the mid nineteenth century. At the same time, however, some remarkable achievements could be made without the advantage of such a base — we may think of 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.

The idea of research was larger than the discovery of underlying general laws. Much of the investigations of the eighteenth century were more in the way of the "three C's": counting, cataloguing, classifying. In that regard, the great figures are the Swedish botanist Carl Linnaeus and his French rival Georges-Louis Buffon, but many contemporaries followed them in an attempt 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 period of the classical Industrial Revolution, and insofar that it did, it was probably not much due to agricultural writings.[6] And yet, the demand side of the market for ideas was there, and the supply was on the way.

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 dispute between a glass that is half full or half empty, because the glass started from empty and slowly filled in the

[6]Voltaire in his famed Philosophical Dictionary (1816, Vol. III, p. 91) caustically remarked that after 1750, many useful books written about agriculture were read by everyone but the farmers.

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 Rumford.[7] The effort put in by Europe's most eminent learned men to improve practical techniques demonstrates that by the second half of the eighteenth century most scientists felt their responsibility to the material world acutely, and made a sincere effort to learn which problems bothered people in the workshops and the fields.

Capabilities.

As noted, progress in science is constrained by the ability of scientists to answer questions, in addition to posing 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. Experiments and observations needed their own techniques, and without the right instruments and techniques, the most enlightened and well-meaning research programs would fail. A steam engine, for instance, required the notion of a vacuum, and would be 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 made by his colleague Laplace, who was as skilled an instrument-maker as he was brilliant a mathematician. During the Industrial Enlightenment, scientific advances were made possible by progress in the tools and

[7]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" (Harris, 1998, p. 220). Harris adds that there may have been real penalties for French steelmaking in its heavy reliance on scientists or technologists with scientific pretensions.

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 feedback mechanism leading from technology to science and 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 some poetic license. One of them was the use of geodesic instruments for the purpose of surveying. 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.[8]

Another increased capability came from mathematics. The use of mathematics in scientific research was itself hardly new in the eighteenth century, but advances in mathematics continuously added new tools to the arsenal of the engineers, and theoretical work in engineering advanced consequently and — with a considerable lag — expanded the supply of good ideas. The input of formal mathematics into technical engineering problems was most remarkable in hydraulics and the design of better waterwheels in the eighteenth century. These attempts reflect the difficulties and slowness of the learning process in applying the newly invented calculus to the dynamic problem of hydraulics.[9] Calculus also found its way into mechanical issues of construction such as the theory of beams, as in Charles Coulomb's celebrated 1773 paper "Statical Problems with Relevance to Architecture." Again, the French led their more pragmatic and less formal British colleagues. The

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[8]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.

[9]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 (Reynolds, 1983).

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 not easy to discern, it is hard to see how sustained progress in the longer run could have been made without it.

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.[10]

Selection

The demand side of a market for knowledge is the foundation of the field of evolutionary epistemology and was popularized by Richard Dawkins and his concept of "memes" that compete for acceptance within human society. A more powerful image of evolutionary selection mechanisms in the market for one set of ideas is presented by Hull (1988). Rather than survey those debates, I accept the notion proposed by Dawkins and Hull (although they differ in the details) that science and technology consist of units that struggle for acceptance in a Schumpeterian world. 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 entire set bound by the isoquant is selected upon by criteria that are largely if not exclusively related to profit maximization. Propositional knowledge, of which

[10]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" (cited by Brock, 1992, p. 147).

science is a part, follows more complex selection criteria (Mokyr, 2005). The fundamental mechanism at work here 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.

Although some scholars such as Ian Inkster (2004) recommend the use of terms such as "reliable" or "tested" knowledge, these terms hardly solve the problem, since what is meant by "reliable" and how the tests are to be carried out are themselves dependent on the specific circumstances. In fact, it is not even true that societies need to choose between inconsistent theories, since 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 how does that happen? Knowledge can be characterized as *tight* when it is held by a wide consensus with high confidence. 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 debates in the seventeenth and eighteenth centuries, and resolving these was sometimes difficult. 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. Part of the platform of the Enlightenment was to leave no stone unturned in its efforts to make knowledge tighter. In this effort, it failed more often than it succeeded, but the effort itself was significant.

For economic history, what matters is not only pure "useful knowledge", that is, ideas about the physical environment but also 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" of any kind, 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.

How did the process of selection among competing ideas change in the eighteenth century? Existing knowledge and ideas tend to develop into orthodoxy, and orthodoxies are defensive and jealous. Many elites found ingenious ways to perpetuate their entrenched status quo, so that intellectual innovation would be only admissible if it were not to 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 that were inconsistent with the intellectual 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.[11] Intellectual innovation of any kind 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."

[11]The explanations of how such intellectual conservatism can be a rational response can vary (Kuran, 1988). 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. Symbols like the sorcerer's apprentice and Prometheus embody the notion that innovation could be dangerous and should be contained and controlled.

To phrase it differently, the market for ideas can rely on any combination of persuasion and coercion. Coercion can be viewed as nothing more than a special form of persuasion, at times used 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 raising the expected costs of their innovations and discouraging them from developing new ideas.[12]

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.[13] Moreover, authority could not dispensed with altogether; the growth of useful knowledge could not proceed without some notion of authority, nor was such authority altogether independent of social standing (Shapin 1994). All the same, the almost absolute power with which the canon of Aristotle, Avicenna, and similar classics had ruled the intellectual world was broken. In the two centuries before the Industrial Revolution, the selection mechanism

[12]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."

[13]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.

of ideas, above all that of natural philosophy and useful knowledge, changed and became less committed to the orthodoxy. Coercion was tried over and over again, but ultimately it was becoming increasingly ineffective in the centuries before 1750.

The exact timing of the decline of orthodoxy in Europe is not easy to establish. Although it may seem 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 does not work. The religious reformers themselves could be quite conservative in other areas, while much of the intellectual innovation took place in Catholic lands.[14] The rise of tolerance was far from monotonic, and even the Papacy experienced swings of progressivism and reaction.

Philosophers and theologians may seem to have threatened the entrenched status quo more than experimental scientists. 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, which at the time were often hard to separate.[15] Geocentric astronomy, of course, straddled astronomy and metaphysics. By the time Galileo was summoned to Rome, this battle 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

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[14]Consider Philipp Melanchton'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 Kesten, 1945, p. 309, emphasis added). 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.

[15]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 to the Pope.

to add a disclaimer that his views were purely speculation. Experimental science could not always be separated from metaphysics either.[16]

The concept of a market for ideas in which ideas are selected freely by individuals on merits other than acceptability by the ruling orthodoxy was itself the main innovation of the seventeenth century. The ideals of tolerance and persuasion by argument and evidence eventually won out. The market for ideas should work in such a way that selection among competing theories or observations be determined by criteria that were unrelated to politics, and that were exclusively determined by the rhetoric of knowledge itself: logic, rigor, experimental evidence, and observation. This idea became closely associated with the concept of the Enlightenment. That such a notion is an ideal that in practice is never achieved, and that all science and knowledge are riven with politics is commonplace, but degree is everything, and the politics of science changed. What was determined in the age of Enlightenment was 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, at least in theory, little impact on selection.[17]

Why did the marketplace for ideas become less coercive and more competitive in Europe at that time? The main argument I submit is that the power of the authorities in charge of defending

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[16] The Flemish 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 quarrelsome 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.

[17] 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 Reid, 2006, pp. 8-9).

the orthodoxy was increasingly constrained by their inability to coordinate their actions over different political entities. That is to say, 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 either been suppressed or possibly never even proposed. 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, often to spite a rival ruler, or because they were genuinely persuaded.[18]

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.[19] In one form or another, then, many of the most influential intellectuals post 1500 relied on the fragmentation of power within Europe to

[18]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." 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. For details, see Mokyr (2006).

[19]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 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.

thwart attempts of the orthodoxy to suppress them. Only when the conservative powers were operating in a coordinated fashion (as occurred in the notorious execution of Jan Hus) did the ruling status quo have a chance to succeed in its attempts to suppress intellectual innovation. The division of 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.

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.[20] By that time, however, suppression was more for face-saving than for any realistic hope that Enlightenment ideas could be suppressed. Rousseau, for instance, could live out his last decade in France.

The market for ideas can thus be seen as the happy 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 they were pursued in 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 coopted many of the ideas of the Enlightenment, creating the oxymoronic "enlightened despots." As a mechanism of epistemic selection, forcible conformism and coercion in Europe lost power.

[20]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.

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 and 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. Secondly, the 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.[21] By the eighteenth century the study of nature had become distinctly less hazardous even for people who tried to upset the applecart.

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[21]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."

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, because the market for ideas in many ways resembles an open-source technology. Knowledge is non-rivalrous, and as Dasgupta and David have noted, requires an institutional set-up unlike any other market. 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. Intellectuals maximized a utility function in which material gains were an argument— but so were fame, respect, and recognition.[22]

To draw the full benefits from a contribution to knowledge, a maximal 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 markets 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

[22]To be sure, as the modern economics of open source technology has emphasized, many of these arguments 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.

of one's country of origin. Moreover, in an integrated world students were free to pick and choose universities mentors as well as diversify their intellectual portfolios. In a 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 an transnational entity that served as 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 (Daston, 1991; Darnton, 2003). During the Renaissance, Europe witnessed the creation of a community of scholars and engineers in which scholars communicated with one another that transcended political and ethnic boundaries. This community 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 conflict with their need for a large and international audience. The Republic of Letters, in practical terms, was a market, not an identity.

Market efficiency depended, however, also 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 they 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. The emergence of open science was central to economic growth because ideas were made accessible to other intellectuals who could peer-review and criticize them. For non-experts, this set-up increased reliability, so that people in the fields and the workshops might be more likely to make use of them. For many decades, this idea remained more wishful thinking than reality.[23]

Thus, 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 greatest "winner" in this game was doubtlessly Newton, whose ideas triumphed in the eighteenth century international market and who became a global superstar. But the careers of other leading scholars also indicate

[23] As late as 1799, one of the archtypical Enlightenment scientists, Count Rumford, sighed that 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." By that time, surely, his statement was no longer wholly valid, and indeed was becoming increasingly less so. Priestley (1768, p. 22) felt that "the politeness of the times has brought the learned and the unlearned into more familiar intercourse that they had before."

this cosmopolitan nature of European intellectuals.[24]

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. Famous scientists were, as a rule, far more mobile that 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 any other market, reflect both supply and demand. The demand for ideas on how economic life should be regarded and controlled reflected, up to a point, the changing interests of a new urban-commercial class that emerged 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 persuasively by Allen (2006) that the high cost of labor relative to that

[24] 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.

of energy might have been instrumental in focusing the minds of British inventors on ways in which to substitute fuel for human labor. 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 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: as a set of ideas that ended up triumphing over competitors, including those of the Baconians, the Newtonians, Diderot, Adam Smith, and Antoine Lavoisier. Europe had an Enlightenment whereas other parts of the world did not because it already had a market for ideas in which the new ideas could compete. It can and should also be seen as a widening of support for the belief that a market for ideas should submit to certain rules and be organized in certain institutions. 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, and similar phenomena, such as the *Kaozheng* ("school of evidentiary and pragmatic research") movement in seventeenth century China made little impact on the economy.

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. "Reason" as such was not enough to generate 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.[25] 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 have 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. But in the years after 1815, the economic sea-change we call the Industrial Revolution would surely have lost steam and eventually fizzled out had it not been for the constant infusion of inputs from scientific discoveries and the gradual widening of the epistemic base of existing and new techniques.

The second Enlightenment idea that mattered to economic growth in the long run was a change in the mercantilist world-view that saw the economic process inherently 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 contest, 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 thought first modified and then abandoned this view. Economics shows that efforts that redistribute wealth rather than create it actually reduce the overall pie because they distort incentives and misallocate resources. While the finer points of this theory 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 meddled with free international trade and internal barriers to limitations on occupational choice, barriers to entry, and the myriad of *privilèges* and exclusionary rights enjoyed by groups and individuals. In much of post-Napoleonic Europe, in

[25]For more details, see Mokyr (2006b).

which modern economic growth emerged in earnest, economic institutions and technological progress were conditioned on the triumphs of the Enlightenment. It was an age in which exclusionary privileges and restrictions on economic freedom had been reduced.[26]

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 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. But it would be silly to write the historical development of ideology as a linear model in which economic interests determined ideology and in which there was no feedback. After all, there were conflicting economic interests bound up with different causes. The *ancien régime* defended itself with vigor. Why did the Enlightenment ideology win?

The marketplace for ideas did not, of course, operate purely on persuasion and rhetoric. The institutions and conventions of the *ancien régime* forcefully resisted the imposition of the new rules, and outside the English-speaking world Enlightenment-institutions had to be imposed by French armies, though it was often cheered on by a part of the population. Another reason that the triumph occurred, as Peter Gay has insisted, was that many of its proponents were insiders and were closer

[26]Guilds and monopolies had been weakened, internal tariffs had been eliminated, and price control of wheat was 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.

to the political establishment than they would be willing 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 coopt them, invited them to their courts, and consulted them.

A further reason why the Enlightenment *philosophes* won out was that they were talented and articulate, and, on balance, more persuasive than their opponents. The writings of Voltaire, Diderot, Hume, and Smith, to name just a few, were effective because they were learned, logical, and met the rhetorical standards of the time. The impact of the writings of Adam Smith on policy makers in Britain and abroad was amplified through its popularization through his followers such as Dugald Stewart and Jean-Baptiste Say. Following 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 I would submit that without it, economic growth may have been significantly slower and may have ground to a halt, as it had done in the pre-1750 past.

A number of pre-1789 attempted reforms in the eighteenth century 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 reform-minded rule lasted less than two years.[27] The biggest triumph of the Enlightenment movement was clearly the establishment of a regime in the United

[27] 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.

States based on its principles. Although the success of these pre-revolutionary Enlightenment reformers in Europe was spotty, since 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.[28] 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 a repressive regime in Britain, and a military dictatorship on the Continent. While these effects were eventually reversed, there was nothing inexorable about the outcome.

The historical dynamics of the changing ideology were ridden with lags, setbacks, and roundabouts. 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 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, and despite important institutional developments, no major scientific breakthroughs occurred. The Industrial Revolution, when it happened, did not dramatically affect the rate of growth nor did it constitute a major application of

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[28] 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 (1966, p. 20).

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. 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 accompanied by 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.