

THE **HISTORY** ESSAY



Joseph Wright of Derby's 1768 painting shows a scientist conducting an experiment on a bird in an air pump. By creating a partial vacuum, the pump helped make steam power possible, laying the foundations for the industrial revolution

HOW EUROPE WON THE RACE TO PROSPERITY

Why were London and Rotterdam, not Beijing and Istanbul, the cradles of the intellectual revolution that triggered the modern age?

By Joel Mokyr

How can we explain the astonishing rise in living standards in the past two centuries? Once we start thinking about the question of the origins of modern economic growth, mused Nobel-prize-winning economist Robert Lucas in 1988, “it is hard to think of anything else”. If even a world-leading

expert on business cycles feels that way, what should professional economic historians feel? The literature on the topic is vast, and it may at first glance seem surprising that anyone could add anything of interest to this thrice-squeezed lemon. Yet the odd thing is that culture – the entire set of beliefs, preferences and values of society, including religion and social and moral attitudes – has so far played a modest role in this literature. Economics has dominated the story. Perhaps this was because the economics profession, where most important work in economic history has been carried out in the past generation, for a long time was hostile to any use of culture in historical explanation.

This has begun to change in the past decade, and so now is the perfect time to ask if there was anything in European culture before 1750 that made it especially susceptible to the astonishing technological and scientific advances that created the ‘Great Enrichment’ (as the remarkable prosperity of the modern age has been termed).

But which aspects of culture are we talking about here? And whose culture? To make any progress, we need to slice up the murky concept we call culture. This is a massive discipline, and too large a chunk to be bitten off by any scholar. So, in recent years, many economists have come to focus on intellectual elites and their beliefs in what writers in the 18th century called natural philosophy (that is, science) and the useful arts (technology).

The people who discovered the power of steam, smallpox vaccination, coke smelting and gas lighting were not run-of-the mill workers – they were, on the whole, highly trained and educated. They were, almost without exception, literate and well read, and in constant touch with others, exchanging and distributing what they called ‘useful knowledge’. Some of these ‘learned societies’ and the places in which they met are still well known – the Lunar Society of Birmingham and London’s Chapter Coffee House society being among the most famous. This new generation of brilliant thinkers had come to believe that, by expanding their understanding of natural phenomena and regularities, they could improve the material condition of humankind. Though this notion seems utterly natural – not to say banal – to anyone today, it was still new and controversial in around 1600, when Francis Bacon first formulated it.

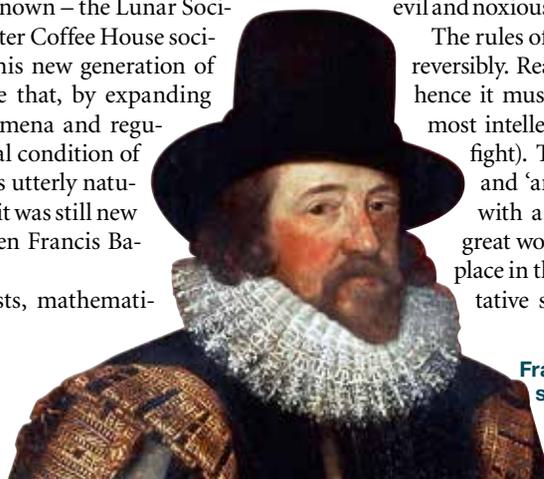
The collaborative efforts of scientists, mathemati-

cians, engineers and skilled artisans proved to be successful beyond even their wildest expectations. The rise in living standards and the material comforts of people around the globe since the industrial revolution must count as the greatest economic event of history – hence Lucas’s remark.

But how did this come about? One place to start is to recognise that, for some reason, humans seem to be hardwired to honour the wisdom of their ancestors and to feel somehow inferior in the face of past learning. Whether they believed in the Talmud, the Qur’an, Confucius, Aristotle or Galen, through history there seems to have been a pervasive conviction that the ‘truth’ had been revealed to our ancestors, and that wisdom was to be found by poring over ancient writings and dissecting them until their true meaning was revealed.

In the 16th century, that belief was irreparably weakened. As late as 1580 an Oxford don could be fined five shillings for teaching something that was contradictory to the writings of Aristotle. But Oxford was behind the curve; by that time the classical canon had come under fire from every corner. The intellectual world of the 15th century was still in the shadow of classical learning, but in the 16th century and beyond it morphed in a world of insolent rebels such as Paracelsus, Harvey, Ramus, Brahe, Boyle and so many others. Driven by new observations, they ripped to shreds the classical texts in physics and medicine, and subjugated them to what they believed to be persuasive evidence and logic. In his pioneering *De Magnete* (1600), William Gilbert announced that he was not going to waste time on “quoting the ancients and the Greeks as our supporters”. The errors he found in classical authors such as Pliny and Ptolemy were spread “much as evil and noxious plants ever have the most luxurious growth”.

The rules of what was true and what was not changed irreversibly. Reasoning that “Aristotle (or the Bible) said so, hence it must be true” was no longer acceptable among most intellectuals (though conservatives put up a good fight). The famous struggle between the ‘moderns’ and ‘ancients’ that took place in this period ended with a resounding triumph for the moderns. The great works of classical antiquity may have retained a place in the curricula of universities, but as an authoritative source on anything to do with the natural



Francis Bacon believed that scientific investigation could improve humans’ quality of life

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world they were decisively dethroned. Once the new breed of thinkers had lifted the leaden burden of the authority of Aristotle, Ptolemy and Galen, and ushered in the age of *in nullius verba* – the slogan of the Royal Society, meaning ‘on no one’s word’ – modernity dawned. Scepticism, it turned out, drives progress.

But why did this attitude prevail in post-1500 Europe – as opposed to, say, the Ottoman empire or China? One factor might be that the great voyages of discovery by the great European powers, and the capability to see and observe phenomena beyond classical knowledge (the invention of the microscope, the telescope and the vacuum pump in Europe, for example) created cognitive dissonances that led to doubt. The same dissonances stimulated the Protestant Reformation, another instance of rebellious and impertinent criticism of what was hitherto sacrosanct. But more was involved.

Economics suggests that new ideas are stimulated by the forces of supply and demand, as well as a society’s cultural beliefs. As a result, philosophers and economists have proposed the concept of a ‘market for ideas’. It is all about persuasion and influence: intellectuals from Luther to Copernicus to Spinoza to Newton came up with new ideas and tried to ‘sell’ them to their constituencies, using evidence, logic, rhetoric, mathematical analysis and experimental results.

The idea of a sale is metaphorical, since no money changed hands. But the benefits to the innovators were real enough. Fame paid off, in terms of patronage. Kings, aristocrats and wealthy bourgeoisie extended benefits to well-known intellectuals, through employment and subsidies. Some of the best scientists of the age were trained physicians who served their patrons as medics. The great Florentine biologist Francesco Redi served as the court physician of the Medicis, as well as secretary and supervisor of their pharmacy and foundry. Leibniz served as councillor to the kings of Hanover. Others, including the young Isaac Newton, found secure employment in universities where tenured professorships were forms of patronage. Such patronage, especially in the cases of intellectual superstars such as Galileo, Newton, Huygens and Leibniz, meant more than financial security; it meant close relationship with people in power, and hence high social status, prestige and legitimacy.

Another reason that pre-1750 Europe proved such fertile territory for new ideas is that the continent was uniquely suited to capitalise on the trade-off between size and competitiveness that is required of any successful ‘market’. Economics teaches that competitive market systems tend to be more productive, more creative, more viable. But for competition to work, there has to be a large number of competitors. At the same time, however, there are economies of scale: big units that dominate their markets can do things that smaller units cannot do. In that sense, the market for ideas encounters the same dilemma: it needs a healthy competitive environment, but in such an environment it may not be able to achieve economies of scale.



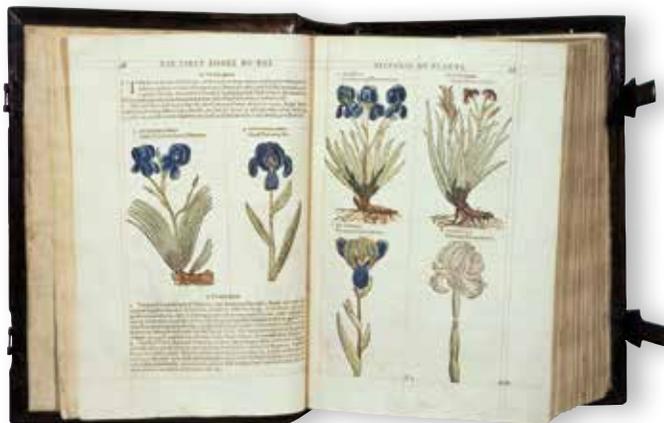
An engraving from Isaac Newton's book *Method of Fluxions*, published in 1736, shows the measurement of a bird's velocity. A group of ancient philosophers, whose teachings had been debunked by the radical new breed of scientists, look on

Now consider the political environment of early modern Europe. The continent was fragmented into many scores of small and medium-sized political units. Notwithstanding the best efforts of the Holy Roman Emperor Charles V, this fragmentation could not be overcome. Even larger units such as Spain and France were divided into competing regions, cities and interest groups. Germany and Italy were splintered into many independent statelets.

This was compounded by religious competition, as the Catholic church lost its monopoly. Such fragmentation (besides leading to endless bloody wars) had beneficial effects. David Hume wrote in 1742 that: “Nothing is more favourable to the rise of politeness and learning than a number of neighbouring and independent states, connected together by commerce and policy. The

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Six varieties of the iris are depicted in *The First Booke of the Historie of Plants* by John Gerard, 1597. In their quest for evidence-based knowledge, scientists began counting and classifying everything from plants to planets

emulation, which naturally arises among those... is an obvious source of improvement.”

In a competitive environment it was difficult for any single polity to suppress novel ideas, no matter how heterodox and heretical they may have felt. Persecution and censorship were of course tried, and some unfortunate intellectuals (most famously Miguel Servetus and Giordano Bruno) lost their lives. But in the long run such efforts were doomed. By being footloose and publishing their works abroad, intellectual innovators could play the political powers against one another. Troublesome writers, such as the Swiss iconoclastic doctor Paracelsus and the Moravian philosopher and educational reformer Jan Amos Comenius, moved across Europe over and over again. The forces of reaction between 1500 and 1700 were powerful and determined, but they lost because they could never co-ordinate their efforts enough. By 1650, reactionary forces more or less gave up. Religious and intellectual toleration won the day.

But precisely because of this fragmentation, there was a danger that creativity might run into issues of size. The number of potential readers who would appreciate the writings of Vesalius or Descartes or Newton in each country or region was too small to make the effort worthwhile. The learned scholars in the 16th and 17th centuries trying to build a reputation with their peers were writing for a European audience, not a Flemish, a French or an English one. What emerged in Europe in the early modern period was an integrated, transnational, intellectual community in which new ideas were distributed, discussed, vetted, evaluated, accepted or rejected on their merits. When a new idea was proposed in London, it was soon enough

discussed in Edinburgh, Paris, Amsterdam, Madrid, Naples and Stockholm. Europe had the best of all worlds: the advantages of fragmentation, without giving up the benefits of a continent-sized audience for innovative intellectual work. The scholarly community that made this market referred to itself as the Republic of Letters and called its members ‘citizens’.

What made it possible was a mixture of ancient and more recent factors. It had medieval roots in the transnational intellectual communities in the Christian church. Latin was still the lingua franca of intellectuals for much of the period. The printing press, of course, made access to writing much cheaper and redefined the parameters of intellectual communication. But epistolary exchanges were at least as important. The growth of trade and communications, and the expansion of a postal system (expensive, slow and unreliable – not unlike today – but indispensable all the same).

Looking at these correspondences (many of which have survived), we can see the tight communications between European intellectuals. The Republic of Letters was a ‘virtual’ community. It connected people who barely knew each other except by scholarly reputation. It was slow but it worked. People at the time were fully aware of its significance. In the middle of the 18th century Voltaire, looking back, reflected that “a Republic of Letters was established, almost unnoticed, despite the wars and despite the difference in religions... all the sciences and arts received mutual assistance this way... True scholars in each field drew closer the bonds of this great society of minds, spread everywhere and everywhere independent... this institution is still with us, and is one of the great consolations for the evils that ambition and politics have spread through the Earth.”

The international nature of the Republic of Letters turned out to be critical to its success. It meant that if a scholar had to seek refuge abroad, he would enjoy hospitality because he was known and appreciated. Hobbes wrote *Leviathan* in Paris and Locke the *Letter on Toleration* in Amsterdam. Pierre Bayle, the French editor of the *News from the Republic of Letters*, worked in the safe town of Rotterdam.

The Republic of Letters, then, was what made the market for ideas work. This is not to say that it inevitably led to the triumph of ‘better ideas’. In vain did Europeans before the second half of the 19th century set out to conquer infectious disease and control electricity.

But there were winners in this market that we still recognise as progressive. The Ptolemaic model (stating that the Earth was at the centre of the Universe) had all but vanished by 1650. Most famously, the recognition of the existence of an atmosphere and the notion of a vacuum jointly made steam power possible. The combination of better geography and mathematics led to the insight that, by comparing the time at any location with the time



The polymath Paracelsus was able to elude reactionary forces by moving across Europe



Cristoforo Monari's *Still Life with Writing Implements* (late 17th/early 18th century). Europe's intellectual revolution was built upon the 'Republic of Letters', a virtual community that enabled scientists to share ideas with like-minded thinkers across the continent

at a fixed point, the longitude of that location could be computed. This challenged clockmakers to make a chronometer capable of doing this – and John Harrison was up to the task.

Yet most important to the victory of reason, perhaps, were the triumphs of meta-ideas. Not ideas on a specific scientific point, but on why and how to do natural philosophy. The 'why' became abundantly clear. As Robert Boyle wrote in 1664, echoing his predecessor Francis Bacon: "If the true principles of that fertill science [physiology] were thoroughly known, considered and applied, tis scarce imaginable, how universal and advantageous a change they would make in the world." Eighteenth-century pioneers of technology came to realise that they needed the knowledge of scientists. By the middle of the 18th century, the great figures of the industrial revolution such as John Smeaton, Josiah Wedgwood and James Watt all sought advice from the intellectuals at the cutting edge of science at the time.

But the change in the 'how' of research in natural philosophy was equally momentous. First, the triumph of experimentalism, the understanding that results from experiments – in opposition to Aristotle – were a valid way of verifying hypotheses in natural philosophy. Experimental science required precision in both workmanship and materials, standardisation of terminology and units, and a clear and detailed communication of experimental work so that it could be reproduced and verified.

Research also became more formal, mathematical and quantita-

tive. Galileo famously wrote that the book of nature was written in the language of mathematics. By 1650 it had become impossible to do serious physics without a strong training in mathematics.

Finally, when formal mathematical analysis would not do, plants and planets could be observed, counted, catalogued and classified. Some famous astronomers and naturalists such as Flamsteed and Linnaeus fall in this category. Patterns and regularities would emerge, perhaps, to show how nature worked.

In short, the argument I'm advancing here goes against historical materialism – the theory that material needs are the engine of progress. I believe that ideas drove history, every bit as much as material conditions drove intellectual change.

For all that, the tale of modern economic growth will be told and retold many times – and surely historians of the future will question the arguments that I have put forward. That, in the end, is what illustrates the glory of a well functioning market for ideas. ■

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BOOK

► **A Culture of Growth: The Origins of the Modern Economy** by Joel Mokyr (Princeton, 2016)