Religion, Culture and the Great Enrichment

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Introduction

In his magisterial *Religion, Technology and the Great and Little Divergences* (2012), Davids, after having spent much of his life studying the economic history of his native Netherlands, finally took up Global Economic History. Like everything he wrote, the book is brimming with learning, keen insights, and a highly original point of view. The title of the book is comes from the term coined by Pomeranz (2000), which described and analyzed the growing economic gap between West and East (better said, between Western Europe and China). At the risk sounding churlish, I would propose that the term "Great Enrichment" proposed by McCloskey (2016, p. 5) is a better term to describe the hockeystick-like time series of income and living standards after 1800 than the "Great Divergence". The latter is a statement about *relative* income between the West and the Rest, whereas "enrichment" points to the *world-wide* increase in every measure of living standards than one can think of. What counts is material improvement, which is what economics is all about. The gap that opened up after 1800 between rich and poor countries is of course a major issue in global history, and has had profound implications. But what drove that divergence were the unprecedented events that started in western Europe in the eighteenth century and that started the ball of economic growth rolling — and rolling it still is. The economies that fell behind the West in the nineteenth century have experienced dramatic improvements in absolute terms as well, even if the gap is still far from closed. Yet if poverty is now declining world-wide, the "deep" reason is the growth of what Europeans called "the useful arts" or "useful knowledge" — the combined, and mutually reinforcing growth of propositional and prescriptive knowledge.

Davids's book came out three years before my *Culture of Growth* (Mokyr, 2016), and I had the benefit of reading it at the last stages of completing my manuscript. While I do not entirely agree

with his argument (as will become clear below), this splendid book, more than almost any other work I consulted for my book, set me to think long and hard about the role of religion and culture in economic development and specifically in innovation and technological diffusion before the Industrial Revolution. Davids's take on religion is quite different from the scholars who preceded him. Whereas the literature on the role religion in economic growth has by and large focused on what people *believed* and how these beliefs affected their actions and interactions, Davids sees the role of religion in technological progress as working primarily through institutions or as he prefers to call it, contexts. Religious organizations played a central role in education and in the circulation and dissemination of ideas. In many cases, they were directly involved in innovation, or provided the incentives for innovators.

It is fair to say that Davids's book takes a materialist approach to technological change. Differences in theology, metaphysics, and religious doctrine, he feels, were not wide and powerful enough to explain the two divergences, the great one between Europe and the East, and the little one within Europe. What matters to him are the organizational manifestations, not the content of religion. In taking this position he clearly challenged my own view (e.g., Mokyr, 2009, p. 1) that "in addition to standard arguments such as geographical factors and the role of markets, politics, and society, the beginnings of modern economic growth depended a great deal on what people knew and believed, and how those beliefs affected their economic behavior." At least as far as religion is concerned, Davids will have none of that. He thus dismisses as unsubstantiated the influential work of Lynn White (1968, 1978) and like-minded scholars who stressed the importance of the anthropocentrism of Western Christianity in people's willingness to engage in innovation, and sees no serious evidence that religious beliefs in any way affected people's attitude to nature, their willingness to study and

harness it, and that differences in such attitudes made any difference as far as technological outcomes are concerned.

Instead, Davids thinks religion mattered because it was always more than just doctrine: worship needed organizations, churches, monasteries, hierarchies, seminaries, clocks, schools, and at times courts, social networks, military organizations, and missionaries. In his view, the main effect of religion on technological progress and economic development should be sought there. The evidence he brings to bear on this arguments is impressive, and consistent with what other scholars have proposed.[1] In this thinking, Davids anticipates the outstanding recent book by Rubin (2017), who has similarly argued that religion played a central role in another "divergence" (one that Davids does not much dwell on) namely the gap between the Muslim Middle East and Western Europe. Rubin's overall approach is quite different from Davids's, but he shares with him a skepticism regarding the economic effects of the actual doctrinal content of religion.[2] He points out, as many other have, that the essence of Islam could not have possibly be as rigid and opposed to commerce and economic change as it may seem, because for the first centuries of its existence, the nations that adopted Islam flourished not just commercially but also in terms of technology, architecture, poetry, agriculture, medicine, and engineering, while western Europe was an ignorant, violent and poverty-stricken backwater. What we are witnessing since 1200 regarding the relative economic positions

[1]White (1978) made the point that monasteries were the vanguard of innovative engineering and agriculture in medieval Europe, and many scholars have pointed to the enormous effect that the Jesuit order has had on education as well as on science (Feingold, 2003). As we will see below, the full effect of Jesuits on the progress of useful knowledge was more ambiguous than Davids suggested.

[2]Rubin points out, as many other have, that the essence of Islamic theorology could not have possibly be as rigid and opposed to commerce and economic change as it may seem, because for the first centuries of its existence, the nations that adopted Islam flourished not just commercially but also in terms of technology, architecture, poetry, agriculture, medicine, and engineering, while Christian western Europe was an ignorant, violent and poverty-stricken backwater.

of Europe and the Middle East is more than a "divergence": it is a Great Reversal, of momentous importance till the present day.

Very similar to Davids's and Rubin's underlying assumptions is the pathbreaking work by Botticini and Eckstein (2012), which asked why Jews were so likely to engage in non-agricultural occupations in an overwhelmingly agrarian world. Here, too, *religion* matters but actual *beliefs* do not, at least not directly. What counts in their account is that, much like Davids's book, religion and human capital were closely linked. Because Jewish males needed to be able to read to participate in what became an intellectual book-centered religion, Jewish parents either invested in their son's education, or abandoned Judaism altogether; as a consequence, through a combination of investment and selection processes, Jews had very high literacy rates relative to their gentile neighbors, and this created a natural source of comparative advantage for them to choose occupations that were literacy-intensive such as trade and finance.

An institutional account of the effect of religion on human capital must of course pay attention to the Reformation even if one wishes to avoid to get dragged into the thrice-squeezed orange of the Weber thesis. Modern scholar has reaffirmed that Lutheranism did have a positive effect on literacy (Becker and Wöeßmann, 2009). Equally important, it created fierce competition in the market for ideas, in which there had been a dominant player for a thousand years. Lawrence Stone (1969, pp. 81-82) has shown how competition for the minds and loyalties of the masses encouraged investment in schools. Modern research has shown this effect to hold for nineteenth century America in which higher education flourished in large part due to religious fragmentation (Xiong and Zhao, 2017).

All the same, what people actually believed may have been more important than Davids and other materialist scholars give it credit for. In all fairness, it is hard to quantify "beliefs" in the absence of data such as the large datasets that exist for our modern age in the form of the World Values Survey and similar compilations, used by economists interested in culture. Moreover, almost anything that can be explained by sets of beliefs may be explained in other ways that may be more attractive in part because they can be easier quantified. Using Occam's razor, perhaps we can dispense with cultural explanations altogether? There is something undeniably mushy about cultural explanations, and it has often been ridiculed by economists.[3] When it comes to religion, a lot of nonsense has been written about it, and Davids does a terrific job debunking some of it in a controlled but most decisive fashion.[4] Yet, I shall make the case that religion may have worked through *both* mechanisms.

Religion and the Attitudes to Nature

Davids takes serious exception to the view that Latin Christendom alone had the willingness and ability to challenge nature because it religion, unlike all others, did not regard the harnessing and manipulation of natural regularities as sinful. Lynn White and his followers argued that if metaphysical beliefs were such that manipulating and controlling nature invoke a sense of fear or

[3] The great economist Robert Solow once remarked that all attempts to explain differences in economic performance and growth using culture "end up in a blaze of amateur sociology" (quoted in Krugman, 1991, p. 93, n. 3).

[4]The most egregious examples of such pseudo-scholarship can be found in the writings of the sociologist Rodney Stark (2003, 2005). Stark argues that somehow Christianity alone created reason and reason led to the Rise of the West. Stark's central doctrine is that Christianity was somehow more "reasonable" than other religions and that modern age is an age of reason. I know of no metric of reasonableness of any religion, though the work of medieval scholasticism obviously tried to place Christian theology on a sound philosophical basis. If Reason means anything, it must mean that hypotheses need to be confronted by facts and rejected if the facts are inconsistent with it. By those tests, Professor Stark's work — ridden with factual errors and logical leaps of faith — seems as good evidence against his own hypothesis as can be found, since whatever else one can find in it, reason is not it.

guilt, technological creativity will inevitably be limited in scope and extent. In his classic work, White (1978) stressed the importance of a belief in a creator who has designed a logical and mechanical universe for the use of humans, who in exploiting nature would illustrate His wisdom and power. I tend to disagree with Davids that White wrongly implied that therefore the ancient world, or East Asia, were not able to make much technological progress simply because they regarded such actions as sinful (but at times as necessary). It is true enough that archaeological findings have to some extent attenuated our views about technological stagnation in the ancient world, and yet it remains true that relative to their achievements in literature, philosophy, and art, the technological advances of the ancient world remain disappointing and that the Middle Ages saw advances that were within reach of the ancient world, but were never realized.

What seems to be a fair judgment is that in *all* societies — including our own — there are conflicting views about what is and what is not ethically right about the exploitation of natural forces.[5] The outcome in these struggles may not always be predictable and surely does not have a one-to-one mapping with any religious belief. Yet a lot depends on the outcome, and it would be as rash to say that it is *entirely* determined by religion as it would be to say that it is *wholly orthogonal* to religious beliefs. The pre-Industrial Revolution world was a profoundly religious environment in which people's metaphysical views about what was sinful and what was virtuous conditioned much of their behavior. The notion that what people believe about the physical world around them matters to their behavior in a variety of situations — including markets and dealing with natural forces in production seems obvious enough. Indeed, it has been argued that a belief in an omniscient and just

[5]Some of the ethical objections to new technology are of course a pretext, masking naked economic interests of entrenched incumbents. For a detailed analysis see Juma (2016).

deity who punishes sins enhances trust and thus reduces transactions costs (Johnson and Krüger 2004; Shariff, Norenzayan, and Henrich, 2009) .

To make progress, it is perhaps worthwhile to clear up one fairly central point. Davids points out, correctly, that White thought that the impact of Christianity on technology and ecology depended on what the "vast 'orthodox' majority...thought [Christianity] was" (Davids, 2012, pp. 38-39). As is being increasingly recognized, what really mattered for the growth of useful knowledge is what a small minority thought: the skilled and possibly educated people who could read, write, calculate, draw, and think about how to improve techniques and designs. This "upper-tail" knowledge is what is crucial in technological advances.[6] Focusing on this elite at the expense of either those who were too poor and too ill-educated to make any advances, or even those who were well-educated but preferred to allocate their human capital in other directions draws the attention to the people who pushed the technological envelope and eventually led to the Great Enrichment. Once we focus on the creative elite of intellectual innovators, some of the pieces fall into place. We can regard Lynn White's medieval monks as part of an intellectual and artisanal elite that helped bring about his *machina ex deo* devices. The notion that somehow Protestant Europe had an edge over Catholic Europe in terms of technological creativity becomes clearly untenable — as Davids fully agrees — when we examine the long list of brilliant Italian experimental scientists that span the centuries between Galileo and Volta.

To be sure, a complete dismissal of the rest of the population as "passive" would be mistaken. Inventions have to be launched into a market environment, and religious attitudes regarding the accumulation of wealth, the charging of interest, and operation of a price mechanism

[6]For a survey of recent work on upper tail human capital, see Mokyr (2017).

in free markets affected the behavior of a much larger segment of the population than just the creative minority. As Deirdre McCloskey, one of the scholars most clearly associated with "ideational turn" in economic history has noted, Christianity was not necessarily inconsistent with capitalism even if it looked askance on great wealth that was unshared. "Jesus, the carpenter lived in a thoroughly market-oriented economy," she points out, and what she calls "prudence" — a practical self-interestedness counts as a virtue (McCloskey, 2006, pp. 253-54, ch. 42). More generally, I think, McCloskey's magisterial trilogy serves as a warning not only against a quick discounting of religious beliefs as a factor in technological and economic development but also as a demonstration that such relations are both complex and protean. Religious dogmas can be stretched, adapted, rationalized to fit the needs of the believer. And yet this does not mean that they are utterly without any effect. After all, as McCloskey stresses, what really counts is *ethics* — what people believed is right and just.[7] Moreover, metaphysics mattered in setting the agenda of inquiry into the secrets of nature. It is perhaps here where the influence of early modern thinking is most marked.

Despite the wealth of works that Davids cites on post-Weber writers about the impact of religion, there is no mention in the text of the most influential of all, Robert K. Merton.[8] In his classic book, Merton ([1938] 2001) drew a direct causal line between English Puritanism and the progress of science in England in the late seventeenth century. The thesis has been enormously

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[7]In a telling passage, McCloskey (2016, p. 422) described the "ideational movement in economic history" and cites Roy Porter (2000, p. 15) to the effect that Calvinism was replaced by a "confidence in cosmic benevolism." Jacob (1997, p. 79) adds that a version of Christianity emerged that "focused on achievements in this world, on a Christianized self-interest."

[8]Merton (1938) appears in the bibliography of Davids's book but in the text there is no mention of his work. There is a single reference to Merton's most eminent follower, Charles Webster ([1965] 2002) on pp. 16-17. Clearly Davids is not persuaded by the Merton thesis (2012, p. 228).

influential and is second only to the Weber thesis (from which it differs considerably).[9] To understand the Merton thesis, it is important to realize that its effect was largely limited to an English intellectual elite whom Merton listed as "Puritans." Such leading intellectuals as John Wilkins, Robert Boyle, the botanists John Ray and Francis Willughby, the mathematician John Wallis, the physician and chemist Jonathan Goddard, and the political economist William Petty, were all committed Puritans. It is not easy to associate Puritanism as such directly with any specific scientific advance, but it is generally agreed that Puritan ideology greatly enhanced the social prestige of experimental science and thus helped prepare the ground for the Industrial Enlightenment.

Merton explained that Puritans embraced science, in part because it simultaneously "manifested the Glory of God and enhanced the Good of Man" (Merton, 1973, p. 232), a line of thinking borrowed from Francis Bacon whom the Puritans admired. For them, as Webster ([1975] 2002, p. 505) has remarked, the ideal life was one that efficiently deployed one's ability for personal advantage and public service and glorified God by maximizing one's material resources. These two objectives were not separable but complemented each other in ways that took until the end of the seventeenth century to be fully worked out. Devout individuals recognized the profound ethical implications of scientific investigation: the systematic and meticulous study of God's creation was the closest a Calvinist could get to an inscrutable deity that could not be grasped by the cultivated intellect. But Calvinism, in the end, had to make room for a set of beliefs in which the laws of science vindicated God's existence (Jacob, 1997, p. 79).

[9] For surveys of the impact of the Merton thesis, some more critical than others, see for instance Cohen (1990); Shapin (1988); Becker (1984); Abraham (1993).

The Puritan ideology thus built upon the Baconian belief that experimental science was a Christian religious activity; Puritanism and Science thus found a common ground in empiricism and experimentalism. Robert Boyle placed on the title page of his book *The Christian Virtuoso* (1690) the statement that the book would show "that by being addicted to Experimental Philosophy, a Man is being assisted rather than indisposed to being a Good Christian." Yet what was true for a Puritan like Boyle was equally true for a deeply religious (closet) Arianist such as Newton. Newton was a deeply religious man, for whom his findings affirmed the ever-presence of a wise deity who had created a world of knowable regularities.[10]

Where Merton and the Merton thesis are at their most vulnerable is in their Anglocentricity. Puritans were far from unique in their ability to reconcile their religion with their science and experimental philosophy. In premodern Europe religious beliefs were driving intellectuals into the kind of research in natural philosophy that became the basis for the growth in useful knowledge that formed an integral part of the Industrial Enlightenment. All over seventeenth-century Europe, science and religion discovered a range of possible symbiotic relations (Gaukroger, 2006, p. 505). In England, as noted, this was expressed in the deep Anglican beliefs of Robert Boyle and the somewhat eccentric but deeply felt religious sentiments of Newton and in the latitudinarian doctrines of the "Low Church." But everywhere similar compromises can be discerned: Italian Jesuits, French Catholic friars, pre-adamites, unitarians, and devout Dutch Calvinists—many of them found a way to reconcile their religious beliefs with their scientific activities.

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[10]While it surely is far-fetched to see in Newton's Arianist (and thus heretical) convictions a driving force for his science, Newton's Christian faith affirmed and supported his scientific work. He could do this by developing eclectic and idiosyncratic religious beliefs that were designed to be consistent with his scientific insights. He ignored the problems that his mechanical theory posed for cosmogenesis and ostensibly adhering to the literal biblical text (Snobelen, 1999). Newton had to struggle with the relation between God and his concepts of time and space and to show how the timelessness of one implied the timelessness of the other (Janiak, 2006).

Whether Catholic or Protestant, natural philosophers in the seventeenth century found evidence of God in Nature, and this was an impersonal mechanical God, revealed in his immutable laws to which he himself was subject. The deity was no longer a judgmental entity concerned with enforcing a morality or granting rewards for good behavior, much less engaged in miracles. As Westfall (1986, pp. 234–35) has put it, the new natural philosophy put forward by such scientists as Kepler, Descartes, and Newton could not avoid the question whether the aspects of Christianity that distinguished it from a more impersonal theism held up in view of their growing knowledge of nature

Ancients and Moderns

There was something unique and unusual about seventeenth century science that may have been decisive in bringing about the Industrial Enlightenment and the Great Enrichment that it entailed. No matter how devout they were, the citizens of the seventeenth century Republic of Letters were liberating themselves from the Tyranny of the Canon, the almost mindlessly uncritical adulation of past wisdom. True progress could not be embraced, as Carl Becker noted many decades ago, until ancestor worship had been abandoned and with it the sense of inferiority relative to earlier generations.

A famous dictum from the Jewish *Chazal* (earlier sages) has it that "if those who were before us (rishonim) were like angels, we are but men; and if those who were before us were like men, we are but asses" (Sabbath, 112, see www.yeshiva.org. il/wiki /index.php?title= "chazal's authority in the determination of the *halacha*"). This was not, in its basic outlook, inherently different from the attitudes to the founding intellectuals of Chinese philosophy Confucius, Mencius, and Xunzi, and

that of Moslems for the Quran and the *hadith* (sayings attributed to the prophet Muhammad compiled in the 8th and 9th centuries). This veneration for ancient knowledge, with its clear religious roots, has had a distinct dampening effect on the ability of many societies to experience knowledge progress, since it imposed constraints on what new knowledge was and was not permissible. It created a semi-rigid box. Within that box, a certain degree of intellectual innovation was possible, and some debates occurred. However, thinking outside that box could entail accusations of heresy.

One of the most dramatic developments in Europe's cultural life after 1500 was the slow but inexorable melting away of the inferiority complex relative to the ancients. In the late Middle Ages a powerful orthodoxy had been established that merged Christianity with Aristotelian philosophy and classical science, the monumental life work of Thomas Aquinas. Yet after 1450, cracks in this structure started to emerge, and in the next centuries it showed serious signs of weakening. In the middle of the sixteenth century, the French philosopher Pierre de la Ramée (1515-1572) already wrote freely "on the errors of Aristotle," and by the early seventeenth century Francis Bacon insolently wrote that "[the Greek writers of science] certainly do have a characteristic of the child: the readiness to talk with the inability to produce anything; for their wisdom seems wordy and barren of works" (Bacon [1620] 2000, aphorism 121, p. 59).[11] In the seventeenth century, the rebellion against the rule of the ancients was in full swing and led to a climactic war of words still known as the *querelle des anciens et des modernes* a battle between the ancients and the moderns (Levine,

[11]Even more impudent was Bacon's countryman and contemporary, William Gilbert, who, in his *De Magnete* (1600), announced from the onset that he was not going to waste time on "quoting the ancients and the Greeks as our supporters, for neither can paltry Greek argumentation demonstrate the truth more subtly nor Greek terms more effectively, nor can both elucidate it better. Our doctrine of the loadstone is contradictory of most of the principles and axioms of the Greeks." The multiple errors he found in such classic authors as Pliny and Ptolemy were spread "much as evil and noxious plants ever have the most luxurious growth." (Gilbert, [1600], 1893, pp. 1–2, 208, 321–22, 339–40).

1981, 1991; Lecoq, 2001).[12] But any notion that this battle ended in a draw as Jonathan Swift implied in his priceless parody of the debate (Swift, [1704], 1753, p. 170) is mistaken: by the late seventeenth century Newton and his contemporaries had hammered the last nail in the coffin of ancient physical science and Francesco Redi had done the same for Aristotelian biology.

For most religious institutions, the irreverence and impudence of the moderns in challenging dogma represented a serious threat. Most famously, of course, the Copernican revolution threatened a view of the universe that had come down from ancient learning and that had been merged into an encompassing synthesis. In this system metaphysics provided a bridge between natural philosophy and theology (Gaukroger, 2006, p. 130). "The resulting system of the Universe was considered impregnable and final. To attack it was considered blasphemy" (White, 1896, p. 120). As Cohen (2012, p. 81) phrases it, "from Coimbra to Cracow and from Vienna to St. Andrews, Aristotelian doctrine and the quadrivium were taught as foundation courses ... this state of intellectual affairs was without precedent."[13] The orthodoxy was nothing if not tenacious. In 1624, the parlement of Paris still prohibited the teaching of material that contradicted "ancient and approved authors." The Jesuits, in some ways a dynamic factor in both the generation and diffusion of new technology, fought heliocentrism tooth and nail, and the Catholic Church dropped its prohibition on books teaching Copernican astronomy only in 1758. Religion had a tendency to be conservative, though this was not invariably the case.

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[12] The classic if perhaps by now somewhat dated statement remains R. F. Jones ([1936] 1961).

[13] In the fourteenth century, Oxford University had a rule on the book that every master who deviated from Aristotle's *Organon* would be fined 5 shillings for every case of deviation (Devlin, 2000, p. 58). This rule was still on the books when Giordano Bruno visited Oxford in ca. 1583. In 1556 A statute at Oxford stipulated the basic texts for the study of fields: Ptolemy for astronomy, Strabo and Pliny for geography and thirty years later students were urged to follow only Aristotle and those who defended him (Rossi, 1978, p. 40). In 1559 a Dr. John Geynes, who had suggested that Galen may not have been infallible, was forced by his furious colleagues to recant (Debus, 2002, p. 174).

Copernicanism and others attacks on the Aristotelian world system based on new scientific insights and new observations were only part of the story. Galenian medicine came under attack from Paracelsus and the iatrochemical school that he founded. The great chemist Jan-Baptist van Helmont and a follower of Paracelsus got in trouble with the inquisition.[14] But philosophical objections were raised as well. Gillespie (2008) points to what he calls the "nominalist revolution" in the Renaissance as the taproot of modernity. The exact philosophical differences between William of Occam, the founder of nominalism, and his scholasticist opponents perhaps do not matter much to the economic historian, but Gillespie's argument that the growing influence of nominalism was critical to a world-view that was more conducive to modernity is rather unusual. In his view, nominalism triumphed over scholasticism in the late Middle Ages, and much in contrast with Lynn White, the nominalism Gillespie sees revealed a fearsome and unknowable God, in which "Man was dethroned from his exalted place in the Universe" (Gillespie, 2008, p. 28). For Gillespie, the key to modernity was to be found in the answers that early modern philosophers found to the "problem posed by the nominalist God within the framework of modern science." The most telling answer was provided by Francis Bacon. Bacon's answer, in Gillespie's view, was radical: people should strive to discover the hidden powers by which nature moves in order to gain mastery over it (Gillespie, 2008, p. 39). Bacon's thought, indeed was pivotal to the emergence of the Industrial Enlightenment, and no less than his medieval predecessors did Bacon place humans in the center of the creation (Briggs, 1996, p. 176-77). Regardless of whether one is convinced by the somewhat overblown position of

[14] In 1625 the General inquisition of Spain condemned 27 of Helmont's "propositions" for heresy, impudent arrogance, and association with Lutheran and Calvinist doctrine. His treatise, *De magnetica vulnerum*, was impounded the following year. He was condemned by the Louvain Faculty in 1622, placed in ecclesiastical custody in 1634, and published nothing between 1624 and 1642. Cf "Project Galileo" http://galileo.rice.edu/Catalog/NewFiles/helmont.html.

nominalism in the shaping of modernity he sketches, Gillespie provided another and novel view of how metaphysical ideas may have conditioned modernity.

The objections raised at the time against other threats to existing knowledge seem, at least from the point of view of today, less plausible. Amir Alexander (2012) has pointed to the tenacious resistance that Jesuits and other conservatives displayed against infinitesimal mathematics. The teaching of such heretical math was prohibited by the Jesuit's Board of Revisors led by the very conservative Jesuit General Muzio Vitelleschi. It was felt that infinitesimals and later calculus represented a threat to the neat logic of Euclidian geometry and algebra. Needless to say, such resistance was futile and the progress of mathematics after the late seventeenth century invention of calculus in the eighteenth century was dazzling. Italian and Spanish mathematicians, so prominent in earlier ages, had to make room for those living north of the Alps (with the notable exception of the Piedmontese Giuseppe Lodovico Lagrangia, later known as Lagrange, who did his most important work in Berlin and Paris).

The relationship between religion and the progress of useful knowledge in this age cannot be summarized simply as either the conflict between progressive scientists and benighted clerics, as Andrew Dickson White (1894) would have it, or as Hooykaas (1972) and others argued, that Christian beliefs were the taproot and inspiration of seventeenth-century science. Religion in this age was a large tent that contained a plethora of attitudes toward science; some aspects of modern science were compatible with some religious beliefs, but on the whole the relation cannot be summarized as either one of conflict or one of harmony. A complex and multivariate interlocking of scientific interests and religious beliefs coexisted within the larger European context, in each community, and often in the same person (Lindberg and Numbers, 1986, p. 10).

Perhaps the most striking "smoking gun" for the importance of religion in this regard is the utter absence of Jewish names in the roster of intellectual innovators in the Scientific and Industrial Revolutions. As I have noted elsewhere (Mokyr, 2011), this is particularly striking in view of the enormous investment in human capital that Jews made in the education of their children. Yet Jewish religion at this time was unusually backward-looking in its doctrine and the extensive scholarship was in part exegesis of ancient sources and in part mystical and kabbalistic. Even in professions such as medicine where Jews were prominent, we search in vain for a Jewish Paracelsus or a Jewish Vesalius.[15] Innovators thinking outside the boxes of traditional Jewish learning were frowned upon and when needed, rejected from Jewish society, as Spinoza found out. Only in the nineteenth century, when Jews became assimilated in a secular culture did their contribution become proportional to the massive amount of human capital they had accumulated.

Mutatis Mutandis, the same is true for China. Confucianism was not so much a religion stricto sensu but a code of ethics and behavior. After its revival in late Song China, particularly with the enormous influence of the writings of the leading Neo-Confucian scholar Zhu Xi, the culture of the elite became increasingly backward-looking and intolerant of deviancy and apostasy. Much as the Mishna and the Talmud and the study of the *halacha* were for Jewish children, Chinese youngsters were immersed in the *Four Books* and *Five Classics*—the summary of the Chinese canon—in a certain sequence, a hundred times each. Rote learning supported the orthodoxy and the "rote reception of that orthodoxy" (Woodside and Elman, 1994, pp. 532–33). The unassailability of

[15] An apparent exception that actually proves the rule is Joseph Solomon Delmedigo (1591–1655), a Jewish doctor and a rather sophisticated citizen of the Republic of Letters, who actually studied in Padua with Galileo, to whom he referred as "Rabbi Galileo." He wrote in his *Sefer Elim* that only a complete fool ("*peti moochlat*") would deny the Copernican cosmology (Delmedigo, 1629, p. 304). The leading expert judges however that "whatever views Delmedigo may have harbored he kept to himself and never divulged in public. ... By that time, his travels and experiences must have convinced him at last that the Jewish world was not yet ready for his kind of views and learning" (Barzilay, 1974, p. 4).

these texts remained the most effective bulwark against troublesome innovators. In China, Sivin has remarked, until the nineteenth century we cannot find scientists willing to abandon values and beliefs that had evolved for thousands of years in the view of "proven facts" (Sivin, [1984] 2005, p. 13).

The more general point to be made here is that religion affected not only one's relationship with a deity but also conditioned one's attitudes toward the wisdom of earlier generations. It is on this point that I think Davids's book needs to be supplemented. The great "divergence" was made possible by the loss of respect with which European intellectuals treated the once -sacred wisdom of Aristotle, Galen, and rest of the classical canon. Why and how this respect for earlier generations took such a beating is a question I have discussed elsewhere, but both the Reformation and the Scientific Revolution bear testimony to the fact that as Carl Becker (1932, p. 131) wrote, European intellectuals had "analyzed away their inferiority complex toward the past, and realized that their own generation was superior to any yet known."

Conclusions

In Karel Davids's *Religion, Technology and the Great and Little Divergences*, global history meets the history of technology. It is a brilliantly erudite treatise based on an astonishing range of reading. His argument that the contexts and the organization of religion were critical to intellectual innovation and technological progress is wholly persuasive. The Latin Church in Medieval Europe laid the foundation of what in the sixteenth century would be widely recognized as the Republic of Letters, and which played a central role in incentivizing the generation and diffusion of useful knowledge in the centuries before the Industrial Revolution. The Republic of Letters, to be sure was largely a secular institution, transnational and transreligious, and while many of its "citizens" were

obviously quite devout, religion as such occupied a comparatively passive role in it. But it is undeniable that it had religious origins. The inspiration for the Republic of Letters was in part the *Respublica Christiana* that harked back to St. Augustine's *City of God*. The Church gave it two gifts that made it work: the preservation of Latin as the lingua franca of intellectuals, and the pan-European transnational networks that made the Church work in the first place. The scholastic intellectuals of the late Middle Ages had constituted a loose transnational intellectual community under the aegis of the church. The medieval idea of the Church as a mystical but coherent scholarly community working together for a common good was retained until and beyond the Enlightenment (Fumaroli, 2015, pp. 121–23). But, as Davids neatly points out (2012, p. 194), there were also less direct spillovers: the idea of "natural laws" may have come out of medieval canon law.

Davids and many other scholars have focused on material incentives and rewards as crucial causes in explaining both the large and the small divergence. He is quite right that we have failed to recognize the important effect that religion had on shaping those incentives. Religious organizations and activities played a large role here, and some of the greatest works of art and music in Europe were created in this way — just think of the Sistine Chapel and the St. Matthew Passion. Yet the people who created useful knowledge of all sorts were also driven by non-material motives. Not all of those were "intrinsic" (Mokyr, 2017). Many scholars wanted recognition and peer-respect, and while reputation was often correlated with patronage and material rewards, that was not all there was to it. Consider the example of Anthonie van Leeuwenhoek, a self-taught and able mathematician, a well-to-do and respected draper, who was hired by the city of Delft in various positions such as surveyor and inspector of weights and measures. Yet his true interest was the manufacturing and use of microscopes, and he communicated his findings (written originally in Dutch) to the Royal

Society in London, which published many of his letters. In 1680 he was elected a Fellow, and clearly this was a source of pride for him.

That said, intrinsic motivation cannot be written off altogether and here, too, beliefs played a role. Europeans slowly retreated from the idea that curiosity was sinful. Huff (2011, p. 112) attributes some of the Great Divergence to a "curiosity deficit" between Europe and China and places much of his explanation for Europe's leadership on Europeans being more "curious." While interesting, Huff's theory raises more difficulties than it solves. Wootton (2015, p. 61n) points out that in the Christian West curiosity was traditionally regarded as a vice and so its transformation from vice to virtue was itself endogenous, a consequence rather than a cause. St Augustine had still regarded it as a vice, but Aquinas already modified this condemnation and by the early seventeenth century the most distinguished members of the Republic of Letters had abandoned this moral condemnation altogether. Francis Bacon warned his readers in *The Great Instauration* not to fall into the error of thinking "that the inquisition of nature is in any part interdicted or forbidden" and cited with approval Proverbs 25:2 that stated that "it is the honor of God to conceal a thing and the honor of kings to investigate them" (my translation from the Hebrew) (Bacon [1620], 1999, pp. 74-75).

Many scholars have seen the rise of secularism as essential to the Enlightenment and the economic growth it entailed. Carl Becker (1932) pointed out that the utopianism and millenarianism we observe in enlightenment intellectuals may have been more secular than two hundred years earlier, and"sacred" had to make room for "natural" and "reasonable." Enlightenment *philosophes* replaced the search for salvation with the search for progress. But as McCloskey (2016, p. 368) has written, "one cannot understand the sixteenth or seventeenth centuries... without acknowledging that

these are serious Christians we are construing." Would the Enlightenment have had a belief in progress without an earlier belief in salvation? China, it is worth remembering, had neither.

To sum up, Davids's magnum opus, which has not yet given the recognition and visibility that it so richly merits, has persuaded me that we cannot write the history of innovation without paying attention to religion, the central pillar of culture of pre-industrial Europe. But his work, cautious and nuanced as it is, underlines that religion could be a stimulant and catalyst for scientific research as much as it could be an obstacle and an impediment. To paraphrase Kranzberg's famous tongue-in-cheek "Law" for technology, religion was neither good nor bad for technological progress, nor was it neutral.

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