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IS TECHNOLOGICAL PROGRESS INEVITABLE?

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Introduction

Since the Industrial Revolution, technological innovation has subjected economies to what the economist Joseph Schumpeter called “gales of creative destruction” (Schumpeter 1994: 82–83). This is a novel experience in human affairs. Between the invention of the plough 10,000 years ago and about 1700 there was technology, but no technological momentum. Technologies came and went; some were known in some places and unknown in others; some were forgotten, others frozen; they remained primitive; there was no basic improvement in ‘man’s estate’ for thousands of years. As John Maynard Keynes noted:

From the earliest times of which we have record – back, say to two thousand years before Christ – down to the beginning of the eighteenth century, there was no very great change in the standard of life of the average man living in the civilised countries of the earth. Ups and downs certainly. Visitations of plague, famine, and war. Golden intervals. But no progressive, violent change . . . This slow rate of progress, or lack of progress, was due to two reasons – to the remarkable absence of important technological improvements and to the failure of capital to accumulate.

(Keynes 1978a: 323)

The “remarkable absence of important technological improvements” should alert us to the possibility that the technological dynamism of the last 250 years, while being a crucial episode in the ascent of our species, is destined to fizzle out as it exhausts its contribution to human well-being. It was the historian Arnold Toynbee who pointed out that automation, by simplifying the apparatus of living, produced a “consequent transfer of energy from some lower sphere of being or action to a higher one” (Toynbee 1974: 198). Keynes himself said the same thing in his essay cited previously: the solution to the problem of production would free humans for the first time in their history to devote their energies to non-economic purposes (Keynes 1978a: 326). Technology, like Mephistopheles, having done its work, could retire from the scene. It is difficult to embrace this view tout court, but we should at least expect a much greater degree of discrimination between the development and uses of different types of technology, with medical technology, for example, continuing to advance, but the pace of work and consumer technology slowing.
The two absences, or failures, mentioned by Keynes — stagnation of technology and capital — are linked. Technology failed to improve because capital failed to accumulate: economists would say it was ‘consumed’ rather than being invested in new tools and machines.

Capitalism was the first social organisation in history to make capital accumulation its object. Its three essential properties were the drive for riches, competition for profit in markets, and concentration of capital ownership in a class of capitalists. Although Karl Marx saw the concentration of capital ownership as the unique property of capitalism, the emergence of capitalist civilisation preceded the concentration of capital and is thus a part of the story of capital accumulation. But capitalism was not solely responsible for the acceleration of technology. Parallel to its emergence as the dominant socio-economic form was the emergence of a scientific outlook, which reoriented intellectual life to the production of useful things. It was this which made a sustained improvement in the tools of production seem feasible and desirable, thus making competition between capitalists for money a social instrument of technological improvement. Capitalism and science jointly reversed the “remarkable absence of important technological improvements” to which Keynes referred.

Capitalism has a strong claim to be humanity’s greatest social invention, by virtue of the fact that it solved for the human species the problem which has plagued all living things: the imbalance between population and resources. From its start, the human population has waxed and waned round relatively fixed means to support it. The Reverend Thomas Malthus made a law out of these historical cycles: owing to its almost limitless fertility, population tended to expand faster than the land available to feed it. The problem of excess mouths to feed was met in one of two ways: starvation or migration. But the cycle then started up again. Fewer mouths meant more food per mouth, and with more food came more children, and so on.

Technology offered a non-tragic solution to the problem by increasing the yield of natural resources. If productivity could keep pace with population, the Malthusian problem was overcome. The technological dynamism of capitalism made this possible for the first time in human history. In fact, capitalist civilisation did better than that: it generated social mechanisms which caused population growth to fall relatively to productivity growth, enabling the world to feed ever greater numbers at a higher standard of living.

However, by making the economy dynamic, capitalism made it disruptive. Since the 19th century the economy itself has been the main source of social disruption. Keynes rightly mentioned the “visitations of plague, famine, and war”. War has been a declining factor in human affairs as economic competition replaced military competition. Plagues and famines continue, but on an incomparably lesser scale than in the past. Instead we have periodic “crises of capitalism”. Capitalism made disruption endogenous. Since the 19th century capitalism has been in the business of destroying old and creating new ways and forms of life. Periodic redundancy of jobs has replaced periodic redundancy of population.

Capitalism and science are yoked together, not in a base-superstructure relation, as Marxists have claimed, but in a complicated civilisational matrix which it will be the purpose of this essay to investigate. How did this unique civilisation arise?

The discussion will be divided as follows: lucky and unlucky geography, attitudes to work, the key institutions, and from religion to science.

**Lucky and unlucky geography**

Although humans are creators of the tools they use, the kind of tools they use and the pace of their adoption has always depended on their location: by location meaning the natural endowments of a given region, including climate. The claim is that different locations give rise to
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different needs and habits of thought and these give rise to different mental outlooks and institutions. These mentalities and institutions persist, rendering the societies which have them ‘path-dependent’ long after the geographic impetus is exhausted.

The geographic hypothesis was invented in the 18th century to account for the perception, of which western Europe had by then become very much aware, that it was forging ahead in wealth from the rest of the world; and it has been extensively used from Montesquieu onwards to explain (and celebrate) the inventive energy of the west in contrast to the supposed lethargy of everyone else.

Jared Diamond’s theory of the ‘lucky location’, in his books *The Third Chimpanzee* (1991) and *Guns, Germs, and Steel* (1997), is the most celebrated recent example of the geographic hypothesis. Rejecting the idea that dominant peoples come from ‘superior’ genetic stock, he argues that those who came to dominate others did so because of advantages in their local environment. His principal claim is that, because of similarities in climate, technology diffuses more readily latitudinally than longitudinally. That is why technologies spread along Eurasia, but not up and down Africa and the Americas.

The most famous historical rendering of the geographical theory is Karl Wittfogel’s *Oriental Despotism* (1957). Wittfogel believed that the way people earn their living determines their institutions, and their institutions in turn determine their receptivity to innovation. The river-based delta agricultures of the Middle East, India, and China favoured ‘despotism’; the rain-based, geographically fractured, farming of Europe favoured warring states and free institutions.

The geographic hypothesis has done sterling work in explaining some aspects of the technological record as revealed by archaeology and history. The ancient empires of the ‘Fertile Crescent’ (Mesopotamia) around 5000 BC to 500 BC, together with those of India and China at roughly the same time, have been called ‘hydraulic civilisations’. Friedrich Klemm writes of the Fertile Crescent:

> The technology of Mesopotamia and of Egypt was to a considerable extent determined by the three great rivers, the Euphrates, the Tigris and the Nile. Irrigation, the building of dykes and canals, the control and utilization of flood waters, were major engineering undertakings on a scale that necessitated organization by the State.

*(Klemm 1964: 18)*

The ability to control river flooding by dykes and earthworks could increase grain production tenfold (Headrick 2009: 18). In China, a major ‘hydraulic’ economy, the first flood control system along the banks of the Yellow River dates from 2200 BCE; the Grand Canal, a waterway of over 1000 kilometres, linking the Yellow River to the Yangtze, dates from about 500 BCE. After a thousand years of hydraulic engineering the country was covered with a network of waterways, which banished serious floods and droughts for 22 centuries. The first Indian population centres from around 6000–5000 BCE were along the banks of the Indus River (in modern Pakistan) and the Ganges basin. The Mesopotamian empires have long since disappeared, but ‘hydraulic’ empires persisted into modern times in China.

All the institutions and practices of the hydraulic economy were built around the need to control water. Not only could these civilisations support far more people than their Neolithic ancestors, “but they also built monuments and cities, invented writing, mathematics, and calendars, and created elaborate religions, literatures, philosophies, and other forms of culture” (Headrick 2009: 17). David Graeber has described how early currencies grew out of the need for a convertible and portable way to pay standing armies (Graeber 2011: 225–228).
Geography can also help explain the original ‘retardation’ of the Mediterranean lands compared with those of the Fertile Crescent. The neoliths of Greece and Italy, who emigrated from Anatolia, “avoided becoming ‘civilised’ as long as possible”, because there were always new lands for foraging and settlement. Not till the first millennium BCE – that is 9,000 years after the Asian settlements – did inhabitants of Greece and Italy come to occupy all the land available and found themselves in the same predicament as others: they had to civilise themselves or perish (Headrick 2009: 34). However, their climatic conditions then started to bring economic and civilisational benefits.

The usefulness of geography as an explanatory tool is not exhausted by considering only ancient economies. Immanuel Wallerstein does not dismiss the factors of “climate, epidemiology, soil conditions” in explaining the “crisis of feudalism” in 14th- and 15th-century Europe, and the search for new land in the west and east to replace depleted seigneurial revenues (Wallerstein 1974). Geography helps explain why the steam engine was invented in Britain and not China, and why it was first applied to railways in Britain and paddle-ships in the USA.¹ A frontier or ‘edge’ culture always differs from an interior one, an urban culture from a rural one. The ‘frontier thesis’ of Frederick Jackson Turner helps explain the enduring mindset of the American mid-west (Turner 2003).

The assertion that today’s ‘virtual networks’ have abolished the importance of location is a claim too far. States, which exist in geographical spaces, and are, to some extent their product, can close down global networks, and have already done so in the name of national security. Yuval Noah Harari’s conclusion is the safest: “Geographical, biological and economic forces create constraints. Yet these constraints leave ample room for surprising developments, which do not seem bound by any deterministic laws” (Harari 2014: 197).

**Attitudes to work**

Technology is labour-saving. As economists tell it, technological innovation is a function of the balance between capital and labour. When labour is scarce (expensive) there is an incentive to substitute capital for labour; with plentiful (cheap) labour this incentive disappears. However, historically, conquest not technical innovation has been the main method of overcoming labour scarcity. Ancient economies were slave economies. Slavery was the fruit of conquest, which brought both more land and more hands to work it. But it was also the product of an attitude of mind which regarded manual work as degrading and ‘fit only for slaves’. The thought that one day this work might be done by ‘mechanical slaves’ occurred to Aristotle, but in his own time there were enough human slaves to make labour-saving irrelevant.

**Paganism and the contempt for work**

Slavery is a property system in which some human beings are owned by others, to be used and disposed of at the will of the owners, just like any tool. With such cheap and pliant human tools at their disposal, property owners lack any incentive to invest in mechanical tools. Slaves made up about one-third of the population of the Roman Empire; slaves were also common at this time in China and India. They were the mobile capital of the classical world, sufficiently cheap to make innovation unnecessary, especially as the installation costs of slaves (conquest) were

¹ Great Britain had “ample deposits of coal, iron, and tin and an indented coastline and navigable rivers that made transportation easy” (Headrick 2009: 92).
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not individually attributable. They enabled the Romans to ignore such productivity-improving devices as the water mill and reaping machine, both invented in the 1st century CE.

The classical ideal of the good life, a mixture of contemplation, politics, and gracious living, was shaped by the fact that the noble class did not have to ‘work’ for its living. In the grandiose cities of the ancient world with their imposing monuments philosophers discussed the principles of good government and the good life; aristocrats “enjoyed their baths, their theatres, and their villas” (Gibbon 1996). In his peerless History of the Decline and Fall of the Roman Empire, Edward Gibbon fixes the years 96–180 CE as the period in which “the condition of the human race was most happy and prosperous” (Gibbon 1996). This view from the top explains the enduring appeal of the aristocratic ideal of leisure. Gibbon says nothing about the happiness of the slaves. The happiness of the few was made possible by the toil of the many. “Technical work” as Klemm puts it, “was the affair of slaves and the free citizen usually despised manual work and even activity devoted to the furtherance of discovery” (Klemm 1964: 42).

Christianity and the duty to work

The end of slavery is conventionally explained by “diminution in the supply of slaves” (Klemm 1964: 62). But it must have, in part, been a cultural choice to abandon a way of life which might hope to replenish the slave supply. Larry Siedentop has drawn attention to the importance of the “impinging of Christian moral norms on social roles” (Siedentop 2014: 165). This happened in two ways. First, the Church’s doctrine of the equality of all in the eyes of God (only God could ‘own’ souls) undermined the classical assumption of human inequality. The ground for the later concept of individual rights was also laid in the church doctrine that the individual rather than lordship was the true subject of the law (Siedentop 2014: 184). Second was the Church’s claim that secular laws had no legitimacy if they contravened laws of God. Thus “Christian beliefs provided grounds for an appeal against injustice that had not been available in the ancient world” (Siedentop 2014: 176). Peasant uprisings started to be not merely in defence of ‘customary’ law, but in defence of a wider concept of justice. Hegel’s powerful attack on the revived slavery of the 19th century was in the name of denying the humanity of both master and slave (Smith 1992: 97–124).

The theological assault on the classical contempt for work pervades Christian apologetics. Early Christian writers often imagined God as the supreme artisan of the natural world, and the marginal status of early Christians “tended to generate among [them] a toleration of labour and laborers not found in the Greco-Roman world” (Ovitt 1986: 490). “Happy is he who earns his bread by the work of his hands” declared John Chrysostom in the second half of 4th century. Disgusted by the decadence of his time, the 2nd-century monk Theophilus of Antioch inveighed against “sloth and levity. repugnant in the eyes of God” (Q in Klemm 1964: 66). The historian Edward Gibbon paid a back-handed compliment to the power of such ideas when he blamed Christianity for the decline in the martial vigour which sustained the Roman Empire. Echoing Gibbon, Nietzsche would dub Christianity the ‘slaves’ religion’.

The Christian ‘duty to work’ drew inspiration from the Old Testament: in Genesis, God created the world in six days, and having worked hard, on the seventh he rested. This was a very different god to the Greek gods, who, while they often had craft skills, but except for Hephaestus, did not toil. Christ was the son of a carpenter, although he gave up work to preach. As a result of these influences, Christianity never had the same disdain for work as the ancient Greek citizens. On the contrary, Christian theology emphasised the value of work and of serving others. Work was a defence against idleness, and tool for charity and expiation.
Because of the ascetic streak in Christianity, work was an important element of monastic life from the beginning. It was institutionalised by John Cassian in the *Institutes* (c. 400 AD), and then St Benedict in his *Regula* (c. 500 AD). The *Regula of St Benedict* not only laid down the rules for organising and governing a monastery, but also laid out strictly what activities should be done at any time of the day or night. In the *Rule of Saint Benedict*, we read that ‘Leisure is the enemy of the soul, and for this reason the brothers must spend a certain amount of time in doing manual work as well as the time spent in divine reading’ (Ovitt 1986: 498). The Benedictine emphasis on the close relationship between manual and spiritual work is summed up in the injunction “ora et labora”, or “pray and work”. The routine labours of daily life, the very fact of their tedium, was spiritualised in the early middle ages.

Paracelsus, a 16th-century alchemist, put the Christian attitude like this: we were not originally constituted for labour. Since the Curse, outside of Paradise, it was ordained that we should work, a course laid on us through the Angel who spoke these words: “In the sweat of thy brow shalt thou eat bread” (Genesis 3:19). Properly understood God’s punishment was not to make people work, but to make work painful, as one would expect for any expiation of sin. No comparable ‘duty to work’ is found in Asian societies. In China, work is not valued in itself, as in Christianity. Physical work, in particular, is condemned as menial. The ultimate aim in life is to reach a position in which one can order others to work rather than work oneself.

The injunction to work carried with it no injunction to innovate. True enough, the so-called ‘Dark Ages’ which followed the collapse of Roman power produced three innovations which ‘set the stage for the modern world’: the mouldboard plough, three-field rotation, and the breast strap for horses and draft animals, the last imported from China (Headrick 2009: 56–58). All three very slowly raised agricultural productivity and made smaller landholdings economically viable.

However, the main response to the problem of labour shortage created by the collapse of the Roman world was a rearrangement of property and political relationships to which the general name ‘feudalism’ is given.

Feudalism is a form of property ownership, in which ownership is formally conditional on fulfilment of obligations and workers are attached to landed estates. It plays a key part in the institutional theory of European technology, both as explaining the initial retardation of technology and its eventual flowering.

Labour shortage was met by attaching cultivators to the land. This was ‘serfdom’, a system of modified slavery in which peasants were guaranteed land in return for labour services: the bottom rung of the system of land in return for services which ran all the way up to the monarch. Serfdom, not technical innovation, was the favoured means of provisioning a shrunken political estate. There was a parallel flight to the monasteries, which acquired economic functions as strongholds of literacy, craftsmanship, and cultivation.

**The key institutions**

It is generally agreed that capitalism started in Europe. The story told by Jean Baechler is severely institutional: states in this region, and especially England, were the first to remove the institutional obstacles to economic efficiency (Baechler 1975). The enabling background was the failure in Europe to re-establish the Roman Empire, and the consequent separation of church and state and the division of the European world into competing states. As we shall see, the institutional view fails to explain why modern capitalism specifically originated in north-western Europe. For this we need a moral hypothesis.

From the perspective of the 18th-century Enlightenment, feudalism was part of the ‘Dark Ages’ between the collapse of Rome and the onset of modernity. By contrast modern institutional
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history sees its structure of weak monarchies, armed aristocracies with juridical functions, ‘free’ cities each with its own rights and privileges, and above all competing of states within a single religious polity (Christianity) as seedbeds of the constitutional state and the private property system. Some historians trace the transformation of feudal Europe into capitalist Europe to the Black Death of 1348, which removed between a third and a half of Europe’s population: a classic apocalypse which forced humans to rethink and redo their political and social relations, their past and future. To the Dutch historian Johan Huizinga (1987), the plague started the replacement of the universal Christian culture of Europe by secular nation states.

The constitutional state

A crucial difference between the European system and that of Asian countries was the fracturing of unified Roman state authority into the separate institutions of Church and State, whereas the Islamic, Indian, and Chinese states remained theocratic. In principle, the institutional separation of religious and secular authority was a functional dispute within a single Christianity polity. In time, though it broadened into a political argument concerning the proper grounds of authority and coercion. The Church’s claim to exercise a co-equal authority with the (largely defunct) Empire (“Render unto Caesar the things which are Caesar’s and unto God the things that are God’s”) was a crucial contribution to the idea of a contractual state.

The Reformation accelerated the separation between church and state. The Protestant revolt against the ecumenical claims of Catholicism brought religious reformers like Martin Luther, Philip Melanchthon, Huldrych Zwingli, and John Calvin the patronage of various European monarchs who saw in Protestantism an ideological basis for nation-state building.

The Reformation thus fractured Papal authority in Europe, splintering and decentring it. It was only in post-Reformation Europe, where even largely Catholic countries like France were riven with deep religious conflicts, that ideas about politics, science, and philosophy as independent from divine revelation could truly take root. If there already existed a significant rift between church and state power in early modern Europe, then the scientific revolution was the wedge to drive the two finally apart.

One important consequence of the Black Death was the gradual disarmament of the nobility and cities and the concentration of ‘law and order’ in the hands of the state. The technical means which made this possible was the application of gunpowder to warfare, perhaps as a response to infantry shortage. Before the development of effective artillery, castles were a huge obstacle to the centralisation of royal power. Gunpowder was invented in China, but not used for military purposes. Its application to warfare in Europe shifted the comparative advantage in violence to monarchies by allowing economies of scale in fighting. By the 15th century it had cancelled the advantages of castles and walled cities: the fall of the heavily fortified Constantinople in 1453 to Ottoman artillery signalled not just the closure of the Silk Road linking the Mediterranean to Eurasia, but the end of the dispersed feudal power system. Europe was gradually consolidated into competitive, centralised monarchies; these monarchies established national markets by breaking down feudal protection of local markets and weakening the hold of the guild system.

To summarise: historians now regard the plurality of feudal institutions as marking a fundamental divergence from the ‘Asiatic’ type of despotic rule, in which the feudal tenure system was weak or non-existent, where religious and secular authority was fused,² and where imperial, not

² The fusion took two opposite forms: in China the state took over the church; in Islam, the church took over the state in the form of the caliphate.
aristocratic, government was the norm. That notable social liberal Montesquieu (2002) likened Europe’s intermediate feudal institutions to the ‘weeds and pebbles’ that lie scattered along the shore obstructing the otherwise overflowing tide of autocracy.

**Private property**

Private property in the sense we know it was born from the collapse of the institution of serfdom. Here again the Black Death played a crucial role. According to David Landes (1988: 18), it “compelled [my italics] the propertied classes to offer substantial inducements to attract and hold the manpower needed to work their estates”. As a result, feudal obligations were gradually commuted into cash rentals, landlords obtained sole ownership of their estates, and a class of free peasants, owing no obligations in cash or kind, but relying for their income on the sale of their products in local markets, came into existence.

A remoter effect of the Black Death was the search for new lands to colonise and fresh supplies of colonial labour. As Wallerstein (1974: 51) explains, “Europe needed a larger land base . . . which could compensate for the critical decline in seigniorial revenues . . . which the crisis of feudalism implied”. Germanic peoples migrated eastwards to the Slav lands and western Europeans to the Americas. The western ‘voyages of discovery’, starting with Vasco Da Gama and Christopher Columbus, were key events in the history of technology: the moment when western Europe broke out of its peninsular confinement on the edge of the Eurasian heartland and found a ‘New World’ for itself. Utilising improved naval technology, Holland, England, and France closely followed Portugal and Spain in grabbing land in the Americas in a modern explosion of ‘slash and burn’, and followed Portugal in establishing mercantile empires in the Pacific. The opening up of oceanic trade routes to replace the now closed Silk Road shifted the location of wealth and power from the Italian city-states of southern Europe to the ‘emerging nations’ of western Europe. The profits of commerce and slavery strengthened monarchies and merchants at the expense of the feudal lords. The ocean opened up an unlimited frontier for ‘new men’ to seek their fortunes.

In the institutional story it is the vesting of property rights in individuals rather than corporations which made innovation profitable. For the first time in history, property in both land and labour was freed up to be bought and sold by individual owners. This was the institutional basis of capitalism, in which the three ‘factors’ of production, land, capital, and labour were subjected to market exchange. This released and prioritised lust for gain and quest for economic efficiency. Competition between ‘capitalists’ incentivised them to install labour-saving machinery to force down labour costs. Karl Marx identified the Darwinian competition between capitalist firms for profit as the taproot of technological dynamism.

The neoclassical economist tells essentially the same story in the language of scientific neutrality. The institutional change most pertinent to technological innovation was the establishment of ‘intellectual property rights’, normally secured by patents, by which governments grant inventors temporary monopoly rights over the products, processes, and techniques which they have invented. This is the only way of avoiding that great disincentive to innovation known as the ‘free rider problem’, the inability of an inventor to profit personally from an invention because knowledge is a free good. In Britain, guarantee of private property in inventions dates from the Statute of Monopolies in 1624, when it was established that the Crown might grant patents (temporary monopolies) only to the first inventors of new manufacturers or processes ‘useful to the state’ and not to anyone it wanted (Klemm 1964: 172). The guarantee provided an incentive to innovate in cost-saving technology. But it was not the only possible stimulus. Between the mid-18th and mid-19th centuries Britain’s Royal Society of Arts awarded over
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2000 innovation ‘prizes’. Whether by way of patents or prizes the requirement was that the 'private rate of return' from an innovation equaled 'the social rate of return' 3.

The economic historian Douglass North compares Britain and Spain to illustrate the power of this hypothesis. The modernisation of property rights in Britain set it on its growth path, by making it profitable for ‘improving’ landlords to capture the profits of their improvements. By contrast, in Spain, the Crown failed to curtail the right of the Mesta (the shepherds’ guild) to drive their sheep across the land wherever they wanted. “A landlord who carefully prepared and grew a crop might expect at any moment to have it eaten or trampled by flocks of migrating sheep”.4 North’s handy formula can be applied generally: the predations of the state can have the same effect as those of the Mesta in retarding technological innovation.5

Protection of private property rights, the rule of law, independent central banks, and the reliance of rulers on parliaments to supply them funds made up a quadrant of related institutions which together freed up capital to create more capital in a property-regime which guaranteed freedom of possession and rights of inheritance.

Historians have explained how countries in western Europe gradually acquired the balance between state power needed to guarantee security of private property against predators and independent legal and power centres needed to prevent the state from becoming predator-in-chief.

This is a fertile explanatory thread. Most historians now trace capitalism’s pathway from the commercial republics of the 15th-century Italian city-states, through the 16th-century voyages of discovery and first overseas European empires, to the almost continuous dynastic warfare between states from between the 16th and 18th centuries. These were the centuries of Europe’s breakout from peninsular to world position: the escape of the whale from the embrace of the bear. Over the same period, the Asian empires stagnated, crippled, as westerners saw it, by their despotic, bureaucratic systems.

From religion to science

The weakness in all institutional accounts of the emergence of capitalism is the failure to link the growth of capital accumulation to the growth of the scientific outlook. They grew together like Siamese twins, but each with its separate personality. The intense competition between states created the free spaces which the scientific outlook needed to gain its territorial hold; while the scientific world view directed the form which capitalist competition took. Together they explain the technological acceleration which took place in the 19th century. The connecting link is Protestantism.

3 But see Klaus Muhlhahn, Making China Modern: From the Great Qing to Xi Jinping (2019: 60). Muhlhahn points out that Qing China had ‘large transaction markets for land’, even though ‘ownership of a single plot could be vested in parties endowed with separate rights over the surface and subsurface. Rights could be sold, leased, or used as collateral. He admits though that property rights in imperial China depended on politics rather than the law (2019: 68). The absence till recently of patent protection in China has been used to explain its technological retardation. The US has seven of the largest ten IT companies, China two, by market value. China is nowhere in pharmaceuticals, whereas the US has six of the top ten.


5 Neoclassical economists consider ‘enclosure’ the rational solution to the problem of ‘over-grazing’, or ‘tragedy of the commons’. Commonly owned property will be over-grazed as each flock owner takes advantage of the ‘free land’ to increase the size of his flock, leading to exhaustion of the land.
This ‘culture of capitalism’ is commonly ascribed to three things: the emergence of Protestantism, the individualistic outlook, and the changed view of nature associated with the Enlightenment. With Protestantism came the view that wealth not poverty gave the best assurance of salvation; with Individualism, the belief in individual freedom as the basis of progress; with the Enlightenment science, for the first time, was harnessed to the discovery of ‘useful’ truths. These pieces of cosmological invention produced a cast of mind in the outstanding thinkers and actors of the time and a pattern of activities and wants in populations which may be seen as the ‘ultimate cause’ of the scientific and technological trajectory.

The Protestant Ethic

The German sociologist Max Weber crucially distinguished between the ‘spirit of capitalism’ and the institutions of capitalist society. In *The Protestant Ethic and the Spirit of Capitalism*, Weber (1930) claimed that the “spirit of capitalism”, by which he meant the spirit of gain, or love of money, far from being inherent in man, entered history at a particular time (16th century) and place (north-western Europe). It was an unintended consequence of the Calvinist doctrine of predestination.6 Calvinists believed that God had divided people into the saved and damned, and there was nothing they could do to influence His selection. Weber’s argument was that they responded to the anxiety produced by this uncertainty with a redoubling of their efforts in order to convince themselves – if not the Almighty – that they were among the saved. Crucially, success in worldly affairs was taken as a ‘sign’ or ‘proof’ of grace. In this way the love of money which had hitherto been regarded as a vice, was turned into a virtue; and the active life privileged over the contemplative one. Calvinism was the most radical expression of the link between salvation and ‘industriousness’; the ‘industrious revolution’ was the moral and ideational foundation of the Industrial Revolution. With this brilliant hypothesis, Weber simultaneously explained both why the spirit of capitalism flowered in Protestant Europe and failed to take root in Asia. It also warns against locating the origins of capitalism in the Renaissance. Renaissance Europe saw a splendid flowering of thought and art. But capital did not accumulate in its centres and there was little technical progress.

Individualism

Liberal political theorists, from the 17th century onwards, were anxious to map out an area of individual freedom immune from external interference. Social contract theories of the state had this as their object. Individuals should be protected from the arbitrary acts of a political tyrant as a matter of natural right. But the functional benefit of individual freedom was also in the mind of political philosophers and economists. David Hume (1741) was quite clear about this: free thought required a limited state. “An unlimited despotism”, he wrote, “effectively puts a stop to all improvement, and keeps men from attaining knowledge”.7 For John Stuart Mill (2003: 76) a century later, the danger was seen to arise not so much from political as from social tyranny: “the tyranny of prevailing opinion and feeling . . . the tendency of society to impose,

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6 Baechler denies this: he sees nothing new about the love of gain, only an expanded institutional means for its expression.

7 A Chinese scholar of the 1st century CE had long anticipated Hume when he wrote of the first Ch’in emperor: “The resources of the empire were exhausted in supplying [Shihuang’s] government, and yet were insufficient to satisfy his desires” (Q. in Goodrich 1948).
by other means than civil penalties, its own ideas . . . on those who dissent from them”. It was in order to protect the genius, the original thinker, the eccentric, in short those persons who advance thought and civilisation, from the despotism of social convention that Mill postulated absolute freedom of thought and discussion and endeavoured to separate “that part of a person’s life which concerns only himself” from that part which is of legitimate concern to society (Mill 2003: 143). It would seem that Mill’s chief concern was to ensure conditions of freedom in which great thinkers can flourish, for, as he observed, original natures cannot be fitted “without hurtful compression into any of the small number of moulds which society provide in order to save its members of the trouble of forming their own character” (Mill 2003: 129). Individual freedom could be justified on utilitarian grounds as a pathway to knowledge. Despite hesitations, Mill subscribed to the scientific idea of knowledge, since for him, as for all Enlightenment thinkers, custom and religion remained the egregious sources of error.

The scientific outlook

Modern science started out as sceptical of theology and has ended up as a new theology, claiming it could read the secrets of the universe better than the old theology. Its claim to God-like knowledge had been foreshadowed by the 13th-century Franciscan friar Roger Bacon who made the case for experimental science.

For there are two modes of acquiring knowledge, namely by reasoning and experience. Reasoning draws a conclusion and makes us grant the conclusion, but does not make the conclusions certain of truth, unless the mind discovers it by path of experience.

(Q. in Klemm 1964: 94)

His 17th-century namesake Francis Bacon attributed the advance in knowledge to the new empirical method of discovering truth. Theology, in the scientific conception, was like magic because its ‘truths’ couldn’t be validated or refuted by experiment: they corresponded only to Roger Bacon’s first principle, drawing a conclusion by reasoning. The question was posed: what if the two methods diverged?

Despite its strong backward-looking bias (“It’s all in Aristotle”), the Renaissance was a bridge between medieval scholasticism and scientific empiricism. Renaissance thought was experimental. In addition to the truth revealed by scholastic reasoning, there was truth to be discovered. Whereas Copernicus was a model-builder, the astronomer Johannes Kepler (1571–1630) set out to verify Copernicus’s heliocentric hypothesis by observation. Kepler’s observations inspired Isaac Newton (1643–1727) to produce a general law which could not be reconciled with religious teaching. Newton was the first purely secular law maker: his general law of motion was the first genuinely scientific law, which applied the force of gravity to both falling apples and orbiting planets. In Newton the man, science, and magic were not yet wholly disentangled, but with ‘Newtonism’ the process of what Weber called the ‘disenchantment’ of nature became unstoppable (Keynes 1978b: 363–374). Nature came to be seen as a machine, subject to physical laws. The subjugation of nature could, in turn, be used to improve the material and intellectual condition of humanity. The idea of a human nature sufficiently plastic to be moulded by science and technology was a logical culmination of this line of advance.

At first this changed world view had little effect on technology. The knowledge embodied in tools was local, ‘tacit’ knowledge, what the Greeks called *phronesis* or skill. The technologies which resulted were local and scattered, not part of a general and advancing body of knowledge.
Unsupported by science, they rose and fell with the particular material and social conditions which produced them. Thus, many technologies simply disappeared with the fall of the Roman Empire.

But from the 18th century onwards, scientific curiosity was stimulated to look for an explanation of why tools worked; and the tool-makers started to look to science to improve their tinkering. The mathematical models of the universe made by scientists could be applied to engineering, so technology in the modern sense was born. Scientists and engineers met and read papers in the learned societies which sprang up in Britain and France in the 18th centuries. Their ideas spread throughout the educated classes, creating a ‘culture of innovation’. Inventors had a market for their wares which ramified further than the traditional public demand for improved military technology. Stimulating the curiosity of the scientist and the ingenuity of the engineer lay an expanded private demand for the comforts and luxuries they promised.

Why Britain?

According to David Landes (1988: 69), Britain was the first society ‘that interposed relatively few institutional barriers’ to fundamental technical innovation. This, crucially, enabled Britain to become what Peter Mathias (2001) called The First Industrial Nation.

Why Britain? In David Starkey’s (2020) words it was a product of a not yet fully understood . . . concatenation of circumstances: of the wealth generated by empire and slavery abroad and of freedoms – political, legal, economic and intellectual at home, all spiced by consumerism and a precocious mass market for luxury goods.

The traditional story starts with a cluster of technical inventions which multiplied the power of human labour. As a schoolboy once wrote: “About 1760 a wave of gadgets swept over England”. The ‘new economic history’ downplays the gadget theory. There was no sudden ‘take-off’ into a technological future. Rather the mis-named ‘industrial revolution’ was a result of a long historical and institutional development unique to Britain. Although ‘enclosure’ of the commons was common in Europe from the 16th century onwards (leading to peasant revolts) Britain developed capitalist forms of agriculture much sooner in a long process of concentrating ownership in the hands of large landlords, going back to the Black Death. This concentration of ownership and the improvements in agricultural productivity which it enabled, forced redundant labour into the towns, where it was cheaply available for manufacture. Long before the Industrial Revolution, England was much more urbanised than France and other Continental countries (Crafts 1985: 37). The English revolution of 1649 had also clipped the wings of its monarchy, forcing it to bargain with landlords and merchants for revenue, and initiating a naval competition with the Dutch for commercial mastery which led the first British empire overseas in North America.

The account given by Nicholas Crafts in *British Economic Growth during the Industrial Revolution* is consonant with that of Douglass North and the new institutional history. Crafts himself mentions the development of the following institutions efficient for innovation: (1) specialist insurance and banking services like Lloyd’s underwriters which reduced the uncertainties and costs of foreign trade, (2) improvements in domestic credit through the development of internal bills of exchange, and reorganisation of government finances in the 1730s which reduced interest rates, encouraged trading in liquid assets, and strengthened the credit basis of country banks, (3) new forms of business enterprises for raising capital and limiting risk: joint stock companies,
Is technological progress inevitable?

limited liability companies, stock and commodity markets, and (4) the replacement of the family as the unit of production by ‘capitalistic’ market-oriented enterprises, starting in agriculture and spreading to industrial like textiles.

Both the strengths and weaknesses of the institutional approach are on display here. It cannot be denied that institutions had to be permissive, even supportive, of technological innovation, but as Joel Mokyr (2017: 5) points out, they do not explain the ‘surge’ of ‘technological creativity’. These were the result of changes in attitudes to wealth and work associated with Protestantism and the changes in attitude to Nature associated with the Enlightenment. What we see is a re-engineering of institutions to make possible what powerful groups in society wanted to do. The scientific-technological idea impelled the creation of institutions needed to give it effect.

Previous societies, too, had been very wealthy: why did they not innovate the institutions needed to put their wealth to productive or different use? The modern answer is that the monarchs, priests, and nobles, power holders, of the pre-modern world preferred to consume the wealth created by producers in wars, church-building, and conspicuous displays rather than invest it in new machines. The gold and silver pouring in from the New World was spent by Spain on both God and Empire. Starting in north-west Europe – Holland, France, Britain – capital was ‘put to work’ for the first time in history. It was reorientation of human thought and activity to pursuit of wealth which finally overcame the Malthusian trap.

Conclusion

The capitalist civilisation which created today’s technological momentum was thus the result of a complex interplay between institutional development and the development of ideas. Neither provides a complete explanation on its own. However, it is the thesis of this essay that technological innovation is both enabled and disabled but not caused by institutions. Innovation is caused by an attitude of mind which makes people spend their energies and money on one thing rather than another. It depends, that is, on a culture of innovation, which is the obverse of the religious culture.

One needs to be clear about this in thinking about the future of technology. The view that technology determines the future rests on the belief that it generates an unchallengeable commentary on itself. If, on the other hand, the technology we use is shaped by reflection about the place of technology in the great scheme of things then the future opens up. Humans choose their own destinies; they are not imprisoned by them.

References