THE CHINESE PRACTICE-ORIENTED VIEWS OF SCIENCE AND THEIR POLITICAL GROUNDS

by Yuanlin Guo and Hans Radder

Abstract. In China, practice-oriented views of science can be traced back to antiquity. In ancient times, the Chinese people independently created and developed application-oriented sciences, but they ignored basic science. In modern times, China learned and introduced Western science and technology as a practical instrument to protect the nation and make it prosperous and powerful. Through technology and production, science has been playing an immediate and major role in the development of socialism since 1949. Since 1978, the Chinese government has always emphasized that science and technology are the primary productive forces. From ancient times to the present, the practice-oriented views of science are grounded in politics. Science has been the handmaiden of politics since the Qin Dynasty. However, this state of affairs hinders the development of basic science, a science that is not oriented toward immediate application. It also hinders open-minded, critical reflection on the downsides or limits of science, which could draw on broader (moral, spiritual, or religious) values.

Keywords: China; history of science; lack of critical reflection; political grounds; practice-oriented views

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Nowadays, most Chinese use the word "science" to refer to both science and technology, by which they mean technology and production.[1] They prefer technology and production to science, because the former are useful while the latter is abstract and impractical. As a result, they believe that the four great inventions (the compass, papermaking, gunpowder, and typographic printing), which are actually technological achievements, are scientific discoveries. More generally, they think that science should serve economic development, or else it is useless. Furthermore, they

Yuanlin Guo is Professor of Philosophy at the Center for Science, Technology and Society, Tianjin University, Tianjin, China, and (during the year 2019–2020) CLUE+ affiliated researcher at the Department of Philosophy, VU University Amsterdam, the Netherlands; e-mail: 13920598310@163.com. Hans Radder is Emeritus Professor of Philosophy and CLUE+ affiliated researcher at the Department of Philosophy, VU University Amsterdam, the Netherlands; e-mail: h.radder@vu.nl.

regard Xuesen Qian (1911–2009), the best-known technologist and engineer in China, as a scientist. In a word, their views of science are thoroughly practice-oriented.[2]

As we explain in the second, third, and fourth sections, the practice-oriented views of science can be traced back to antiquity and have continued to be a major factor in Chinese history. In ancient times, the Chinese people independently created and developed application-oriented sciences such as agriculture, medicine and astronomy, and the technology characterized by the four great inventions, but they ignored basic science. In modern times,[3] China learned and introduced Western science and technology as a practical instrument in order to protect the nation and make it rich and powerful. Through technology and production, science has been playing an immediate and major role in the building up of socialism after 1949. Since 1978, the Chinese government has always emphasized that science and technology are the primary productive forces. At present China is energetically advancing science and technology to make the nation more powerful and prosperous.

Thus, the Chinese views of science from ancient times to the present are strongly practice-oriented. Generally speaking, the Chinese are not interested in basic science and metaphysics; they are practical and realistic. In particular, in China, the impact of religion on government has been negligible, in contrast to the role played by Christianity in a large part of Western history. On the contrary, although the Chinese people have founded or received a variety of religions (Buddhism, Taoism, Christianity, Islam, Confucianism), these religions have always been controlled and dominated by the government and have been directed toward practical purposes. As the well-known writer and scholar Yutang Lin (1895–1976) puts it, "in China one does not have to learn to become a realist: here one is born a realist" (Lin 2002, 53). What are the causes of this? Of course, there are many. But we argue (in the fifth section) that the political factor is the most important. Science, technology, philosophy, and religion have been the handmaidens of politics in China since Shi Huang Di (259–210 BCE), the first emperor of the Qin Dynasty.[4]

This state of affairs has had two important consequences. The first is the systematic underdevelopment of basic research. A major problem of this neglect is that it is this kind of research that provides the best chances for addressing unforeseeable future challenges. Related to this is the fact that it is often basic science that motivates critical reflection on the broader significance of science, including its relation to religion. Therefore, systematic metaphysical or moral debate on the relation between religion and science has been rare.

The Practice-Oriented View of Science in Ancient China

It is generally accepted that mathematics, agriculture, astronomy, and medicine are the primary and most important sciences in ancient China.[5] However, they are application-oriented sciences, because they were generated and developed for various practical purposes.[6] Clearly, agriculture and medicine are practice-oriented and utilitarian sciences. The former is used for doing farm work and the latter for curing diseases and improving health. Furthermore, in ancient times, Chinese scholars studied astronomy not for astronomical laws and theory, but for calendars and astrology. The imperial court needed a calendar to administrate its country because China was a gigantic and diverse empire. Moreover, a calendar was useful for agricultural production. Chinese astronomers observed the heavenly bodies and recorded strange celestial phenomena and relevant political events to find portents for the imperial court. Thus, Chinese astronomy belonged to and served government. Seventeen out of the 24 histories written by the imperial courts record and describe astronomical phenomena in special chapters (Xi 2003, 136). While the imperial court had set up an astronomical observatory in China as early as circa 2000 BCE, the governments in Europe did not do so until the seventeenth century (Xi 2003, 139).

Mathematics is abstract, theoretical, and systemic by nature, but in ancient China, it lacked theory and a deductive system and was confined to the field of practically useful algorithms. For example, the *Nine Chapters on the Mathematical Art* (*Jiu Zhang Suan Shu*, about the first century CE) and the *Mathematical Treatise in Nine Chapters* (*Shu Shu Jiu Zhang*) by Jiushao Qin (1208–1268), the greatest representative works of the Chinese mathematical tradition, are collections of practical problems and problem-solving operations. The former consists of nine chapters with a total of 246 problems, which are listed as follows:

Fangtian (Land Surveying), 38 problems;

Sumi (Millet and Rice), 46 problems;

Shuaifen (Distribution by Progression), 20 problems;

Shaoguang (Diminishing Breadth), 24 problems;

Shanggong (Consultations on Engineering Works), 28 problems;

Junshu (Impartial Taxation), 28 problems;

Yingbuzu (Excess and Deficiency), 20 problems;

Fangcheng (Calculation by Tabulation), 18 problems;

Gougu (Right Angles), 24 problems.[7]

The above list clearly indicates that the nine chapters and 246 problems are classified according to application and are mainly intended for practical use.

Similarly, the *Mathematical Treatise in Nine Chapters* of Jiushao Qin contains nine chapters with a total of 81 problems. The nine chapters are as follows:

> *Dayan Lei* (Indeterminate Analysis);
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> *Tianshi Lei* (Heavenly Phenomena);
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> *Tianyu Lei* (Boundaries of Fields, i.e. Surveying);
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> *Cewang Lei* (Telemetry, i.e. Measuring at a Distance);
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> *Fuyi Lei* (Taxes and Levies of Service);
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> *Qiangu Lei* (Money and Grain; or Taxes);
>
> *Yingjian Lei* (Fortifications and Buildings; On Various Architectural Problems);
>
> *Junlv Lei* (Military Affairs);
>
> *Shiwu Lei* (Commercial Affairs). (quoted in Libbrecht 1973, 54)

Qin classifies the nine chapters according to the above fields of practical application, including trade, surveying, building, financial affairs, taxation, chronology, astronomy, and military calculations. Qin himself says about his book: "As for the details [of the mathematical problems], I set them out in the form of problems and answers meant for *practical* use" (Libbrecht 1973, 8).

Comparing these two books shows that *Shu Shu Jiu Zhang* is not more profound or advanced than *Jiu Zhang Suan Shu*, although the former was written about 1,200 years later than the latter. They have equivalent structures and ways of thinking. In ancient China, mathematics was neither science nor theory, but art. Propriety, music, archery, charioteering, writing, and mathematics are known as the Six Arts. This clearly shows that mathematics was considered as a technique, the same as propriety, archery, or charioteering. The two books are utterly different from Euclid's *Elements,* a theory of mathematical proof and a deductive system on the basis of a few premises and concepts. The *Elements*, the most outstanding representative of ancient Western mathematics, does not deal with practical problems, but favors logical deduction and proof. For this reason, it was difficult for Chinese scholars to introduce and accept the *Elements*.

China had obtained the Arabic version of Euclid's *Elements* by 1273 (Wang 2016, 67). However, few scholars were interested in it. Therefore, it was not translated into Chinese and had no influence on Chinese thinking. Only about 330 years later, in 1607, a Chinese scholar Guangqi Xu (1562–1633) and an Italian Jesuit priest Matteo Ricci (1552–1610) translated the first six parts of the *Elements* into Chinese. At that time, the *Elements* was still unknown to Chinese literati, who were unwilling to get to know it. For this reason, the last nine parts of the *Elements* were not translated into Chinese until 1856 by the Chinese mathematician Shanlan Li (1811–1882) and the English missionary and sinologist Alexander Wylie (1815–1887). It took 250 years to translate all 15 parts of the *Elements* into Chinese. Moreover, in 1856, nearly 600 years had passed since 1273, when the *Elements* first reached China.

Thus, the reception of Greek mathematics in China proved to be very difficult. Plato (c. 429-c. 347 BCE) believed that geometry, calculation, and astronomy facilitate our contemplation of the essential form of the Good, and that we pursue them in order to know, and not for any utilitarian end. Concerning geometry he wrote, "In reality I conceive that the science (geometry) is pursued wholly for the sake of knowledge. That the science (geometry) is pursued for the sake of the knowledge of what eternally exists, and not of what comes for a moment into existence, and then perishes" (Plato 1998, 240).

In short, Platonic mathematics was pursued for the sake of the knowledge of eternal existence, but Chinese mathematics was pursued for the sake of transient practical purposes. From the Platonic perspective, mathematics is merely simulated by astronomy, so astronomy is subordinate to mathematics. As Plato puts it, "Hence we shall pursue astronomy with the help of problems, just as we pursue geometry: but we shall let the heavenly bodies alone, if it is our design to become really acquainted with astronomy, and by that means to convert the natural intelligence of the soul from a useless into a useful possession" (Plato 1998, 244).

Therefore, the well-known book by Ptolemy (the second century CE) is not considered to be a mathematical work but an astronomical one, although its name is *Mathematical Syntaxis*. In contrast, the astronomical book *The Gnomon and Circular Path (Zhou Bi Suan Jing)* ranked first among the 10 official mathematical textbooks in ancient China.[8] In fact, however, it only deals with astronomical calculations. This demonstrates that, in China, mathematics is the servant of astronomy and calendric sciences, and it mainly focuses on production practices.

As mentioned above, it was difficult for China to introduce and accept the *Elements* because of its logical deduction and proof without any relation to practical purposes. Similarly, the *Art of Mending (Zhui Shu)* by Chongzhi Zu (429–500) and his son Geng Zu (his dates of birth and death are unknown) got lost, presumably because it included more proof and argument than the other official mathematical textbooks. In this book, the value of π was calculated more accurately than before and the formula of the volume of the sphere was deduced. Although it was 1 of the 10 official mathematical textbooks in the Sui and Tang Dynasties (581–907), it was difficult for the official scholars to understand it well. By the time of the Song Dynasties (960–1279), this book could no longer be found.

In sum, in ancient China, basic science and metaphysics were rare because they were impractical. Guantao Jin (1947-), Hongye Fan (1942-), and Qingfeng Liu have statistically investigated the structure of ancient Chinese science and technology and came to the following conclusion: "Calculating the total score of the achievements of Chinese science and technology, we find that the cumulative score for technology is as high as 80%, theoretical achievements 13%, and experimental achievements only 7%. This shows that the level of ancient Chinese science and technology is represented primarily by the level of technology" (Jin et al. 1996a, 140).

For this reason, Youlan Feng writes, "in one word China has no science, because of all philosophies the Chinese philosophy is the most human and the most practical" (Feng 1922, 260). Here, by science, Feng means basic science. That is, ancient China had no basic science. The Chinese way of thinking is described as practical rationality by Zehou Li (1930-), a major contemporary Chinese philosopher. Practical rationality makes the Chinese concentrate on actual reality, so it is against the supernatural, religion, metaphysics, and theory (Hua 1995, 113). Therefore, in ancient times, Chinese literati studied books not for the sake of knowledge, but for power, money, and beauties. They did not possess much curiosity or wonder. Even if people studied assiduously, abstract study was seen as a pain. This is clearly shown by the well-known Chinese saying "Xuanliang Cigu", meaning "tying one's hair to a beam and pricking one's thigh with an awl to keep one awake while reading books at night."[9] The Chinese derided basic science, abstract philosophy, and religious metaphysics. For example, Heng Zhang (78–139) was a famous scientist who was well versed in astronomy and mathematics, but some officials considered his science to be the "skill of killing dragons"[10] because it was impractical.

Another illustration is the popular story of "Qiren Youtian." It is about a man living in the State of Qi in the Zhou Dynasty (1046–256 BCE) who fears that the sky might fall down.[11] From ancient times to the present, the man has been the object of ridicule in China because of wondering about something so unrealistic. In contrast, Kepler (1571–1630), Galileo (1564–1642), and Newton (1642–1727) did explain why the sky does not fall down, and so became among the greatest scientists in the West. Aristotle (384–322 BCE) contrasts the science of production to a free science and states about the latter:

> That it is not a science of production is clear even from the history of the earliest philosophers. … Therefore since they philosophized in order to escape from ignorance, evidently they were pursuing science in order to

> know, and not for any utilitarian end. … Evidently then we do not seek it for the sake of any other advantage; but as the man is free, we say, who exists for his own sake and not for another's, so we pursue this as the only free science, for it alone exists for its own sake. (Aristotle 2012, 6–7)

Thus, according to this influential view in Western antiquity, a free science that exists for its own sake is seen as more important and influential than the science of production. By contrast, the former kind of science was neglected in ancient China, guided by the practice-oriented view of science.

The Practice-Oriented View of Science in Modern China

In modern China, traditional Chinese science was replaced by modern Western science, which was more useful in protecting the nation and making it rich and strong. But although modern Western science is more abstract, theoretical, and systematic than the traditional Chinese science, this shift did not change the practice-oriented view of science. However, outside China critical reflection on modern science revealed a variety of potential tensions between its basic results and metaphysical, spiritual or religious worldviews. For this reason, many scientists have been struggling with these issues and have tried to harmonize their scientific and their broader worldviews. Isaac Newton, for example, interpreted nature and its laws not in terms of their practical usefulness, but saw their purpose and beauty as a clear sign of their divine origin (Dijksterhuis 1961, Part IV, Chap. III-Lc). Generally speaking, the practice orientation of traditional Chinese scholars prevented a real understanding of these matters.

In 1607, when the first six parts of the *Elements* were translated into Chinese, Western science began to enter China and the indigenous science began to disappear. However, it was foreign missionaries who preached Christianity with the help of Western science, while few Chinese literati studied it on their own initiative before the Opium War of 1840. Thus, the missionaries employed science to serve religion. In this respect, their approach to science was also practice-oriented.

After the Opium War, China was in crisis and needed to introduce and develop Western science, technology, and industry (but it kept attaching far more importance to technology and industry than to science). Zhidong Zhang (1837–1909), a prominent minister in the later Qing Dynasty, proposed the well-known policy "Chinese learning for essence and Western learning for functions." Here, essence refers to traditional Chinese systems of ideas and procedures, while Western learning denotes Western science and technology, which is used for practical purposes only. For example, the Westernization Movement[12] established the munitions, shipping, railway, telegraph, and mining industries. At the same time, paper mills, silk filatures, textile mills, metal works, and match factories were springing up in some cities. For this reason, China regarded the term "modernization" as only referring to technology and industry.

Unfortunately, it neglected basic science and philosophy, especially "the invention of the method of invention" that Alfred Whitehead (1861–1947) emphasizes. He claims that the method of invention is far more important and influential than the machines and industries themselves.

> The greatest invention of the nineteenth century was the invention of the method of invention. A new method entered into life. In order to understand our epoch, we can neglect all the details of change, such as railways, telegraphs, radios, spinning machines, synthetic dyes. We must concentrate on the method in itself; that is the real novelty, which has broken up the foundations of the old civilization. (Whitehead 1948, 98)

This novel method includes "the discovery of how to set about bridging the gap between the scientific ideas and the ultimate product" (Whitehead 1948, 98). However, in modern China, these scientific ideas, and basic science in particular, were ignored in the dominant practice-oriented view of science.

The Sino-Japanese War of 1894–1895 marked the failure of the Westernization Movement. At the time, some Chinese realized that people should learn more Western science apart from Western technology and industries. For this purpose, in the 1890s, the Chinese government founded Beiyang University and Beijing University. It seemed then that China started to attach more importance to science. For instance, "science" and "democracy" were the two great catchwords of the May 4th New Culture Movement (1917–1927). Since then, the advocacy of science has been popular in China, but again not for the sake of science itself. Science proved to be not only an instrument of material production but also of ideology building and ideological struggle. As Yuzhi Gong (1929–2007), a leading Marxist theorist, puts it:

> Science, as a weapon in ideological struggle as well as an instrument which changes material productivity, pushes history forward and transforms society. Progressive people who supported science during the May 4th Movement primarily had in mind its function as an ideological weapon in the struggle against the darkness and ignorance of feudal, philistine ideology. On the other hand, at that time people also emphasized the function of scientific development in vitalizing industry, hoping to cure the long-standing weakness and poverty of old China by means of science and industry. (Gong 1996, 14)

In short, "science can save the nation."[13] At that time, many Chinese knew Francis Bacon's (1561–1626) best-known adage: "knowledge is power," from which it follows that "science is power." Under these circumstances, what the Chinese were interested in was not science, but power, especially the power to save China and make it prosperous and strong. For instance, Enlai Zhou (1898–1976), a prominent Chinese statesman in the People's Republic of China, answered, "I learn for the rise of China" when he as a pupil was asked why to learn. This story about Zhou has been a standard text in primary school Chinese textbooks since the 1950s.

Thus, like in antiquity in modern times, the Chinese kept using Western science as a practical tool and stuck to their practice-oriented view of science. As Cyrus Peake (1900–1979) puts it, "this narrow pragmatic conception of the value of Western science persisted in the minds of reforming officials into the present century. They were unaware of the existence of pure science as an independent body of learning, nor did they possess any appreciation of its spirit and its method" (Peake 1934, 183). Here, by reforming officials, Peake refers to Zhidong Zhang and Hongzhang Li (1823–1901), among others. These reforming officials preferred application-oriented science and technology to basic science, and so did the large majority of the Chinese.

In 1883, the American physicist Henry Rowland (1848–1901) criticized the Chinese practice-oriented views of science in an address to the American Association for the Advancement of Science:

> To have the applications of a science, the science itself must exist. Should we stop its progress, and attend only to its applications, we should soon degenerate into a people like the Chinese, who have made no progress for generations, because they have been satisfied with the applications of science, and have never sought for reasons in what they have done. The reasons constitute pure science. They have known the application of gunpowder for centuries; and yet the reasons for its peculiar action, if sought in the proper manner, would have developed the science of chemistry, and even of physics, with all their numerous applications. By contenting themselves with the fact that gunpowder will explode, and seeking no farther, they have fallen behind in the progress of the world; and we now regard this oldest and most numerous of nations as only barbarians. (Rowland 1883, 242)

Rowland made a compelling plea for basic science, and in doing so, he also criticized the contemporary American approach to science. In the 1880s, many American scientists focused on applications of science, but overlooked basic research. It prevented America from advancing science. Therefore, Rowland urged that America should attach more weight to pure science. As a matter of fact, through developing basic research, America has become the scientific center of the world since the 1920s. In contrast, in China, few people made a plea for basic research or criticized the dominant practice-oriented views.

Grace Shen has researched the development of science and technology in the twentieth century and concluded that the modern history of Chinese science and technology should be studied from a practical perspective. From this perspective, she questions the common uses of the notion of utility.

> Applied science offers one model. But many Chinese supporters of pure science also made claims of utility: pure science would produce more practical good in the long term; pure science would help China catch up to the West; pure science would help China resist following the West blindly; pure science would generate interest among youth; and so on. Republican archaeology was a science without clear practical applications, but it was promoted as a way of challenging and rewriting national origin stories. Republican geology did have obvious economic value, but high-profile theorists like Li Siguang saw it as a pure science that would gain China international respect. It seems time to stop thinking in terms of "pure" and "applied." (Shen 2007, 595)

To avoid misunderstanding of our overall position, three qualifications should be added. First, we are aware that some of the quoted arguments for the primacy of basic science (e.g., those of Whitehead and Rowland) strongly suggest a linear model for the relationship between science and technology. In this model, basic research precedes, and is taken to be the motor of, technological development. This model has been rightly criticized by many scholars (see, e.g., Grandin et al. 2004). However, this criticism only applies to a specific account of the relationship between science and technology. It does not disqualify the idea and significance of basic science as such. Furthermore, we agree with Shen that the idea of *pure* science is problematic, and instead use the notion of basic science. We also emphasize the societal "utility" of this basic science (although we prefer to speak about its "public interest"). In spite of this, we insist (see Radder 2019, chapters 1 and 7) that it is still important to keep thinking in terms of the significant differences between (the public interest of) application-oriented and basic research. Finally, it is true that application-oriented research has always been an important and legitimate part of scientific practices. What we criticize in the case of China, however, is the extreme reductionist view that only practice-oriented sciences possess social relevance.

The Practice-Oriented View of Science in China since 1949

Since 1949, Marxism has been the only political ideology to which everyone must submit in China. The Chinese view of science has to be based on the guiding Marxist ideology. The views of science that are prescribed by Marx (1818–1883), Engels (1820–1895), Lenin (1870–1924), Stalin (1879–1953), Mao (1893–1976), and Deng (1904–1997) play a decisive role in the development of science.[14] Their statements about science clearly demonstrate a practical attitude, even if they are not exactly alike. Especially, they always emphasize that science as a practical tool should serve to satisfy the immediate practical needs of society and the nation.

Especially the remarks on science by Engels have great significance for the Chinese government and are often recited by many scholars in China, as the following examples show:

> Science is the revolutionary force pushing history forward. (Engels quoted in Xi 2001, 99)

> The emergence and development of science has been determined by production from the very start. (Engels quoted in Xu and Fan 1982, 9)

> To a great extent technology is contingent on the progress of science, then how far science advances is to a still greater extent contingent on the condition and needs of technology. Once society comes to have technological needs, then these needs will push science forward more effectively than a dozen universities. (Engels quoted in Xu and Fan 1982, 9)

From these oft-quoted remarks, it is concluded that science is not independent. While Aristotle distinguishes between free and productive science, Engels eliminates a free science that is practiced for its own sake and claims that science only consists of productive science. Thus, his view of science is thoroughly practice-oriented. On the one hand, the emergence and development of science is determined by production and actual needs; on the other hand, science performs services for technology, production, revolution, and so on. Besides, Engels believes that mathematics derives from practical needs and applies to practice just as the other sciences do (Marx and Engels 1976, 77–78). His view of science is similar to the traditional Chinese view and it has had a significant impact on the situation in China since 1949.

Zedong Mao (known as Mao Zedong in the West) incorporates Marxism-Leninism into the Chinese tradition and experience. In his 1937 article “On Practice,” Mao makes the following claims:

> The dialectical-materialist theory of knowledge places practice in the primary position, holding that human knowledge can in no way be separated from practice. … Thus, Lenin said, “Practice is higher than (theoretical) knowledge, for it has not only the dignity of universality, but also of immediate actuality.” … The other is its practicality: it emphasizes the dependence of theory on practice, emphasizes that theory is based on practice and in turn serves practice. … Only social practice can be the criterion of truth. (Mao 1977, 297)
> All genuine knowledge originates in direct experience. (Mao 1977, 300)
> There can be no knowledge apart from practice. (Mao 1977, 301)
> If we have a correct theory but merely prate about it, pigeonhole it and do not put it into practice, then that theory, however good, is of no significance. … The knowledge which grasps the laws of the world must be redirected to the practice of changing the world. (Mao 1977, 304)

According to the above phrases, Mao’s view of knowledge and theory reduces the value of science to its immediate practical usefulness. He holds that theory, including scientific theory, arises from practice and in return serves practice, and he particularly emphasizes that theory is futile if not applied to practice. In short, Mao stresses the practicality of science and claims that science must meet the immediate needs of social practice.

But then, what is meant by "social practice"? In the above-mentioned article "On Practice," Mao points out that social practice takes the following forms: material production, class struggle, scientific experiment, political life, and scientific and artistic pursuits (Mao 1977, 296). If social practice is defined in this way, it looks as if scientific theories may be legitimately employed in experimentation and other scientific pursuits, apart from material production, class struggle, and artistic pursuits. If so, science seems to be at least sometimes independent of material production and class struggle. However, in the later 1942 article "Rectify the Party's Style of Work," Mao confines social practice to struggle for production and class struggle.

> Ever since class society came into being, the world has had only two kinds of knowledge, knowledge of the struggle for production and knowledge of the class struggle. Natural science and social science are the crystallizations of these two kinds of knowledge, and philosophy is the generalization and summation of the knowledge of nature and the knowledge of society. (Mao 1975, 39)

> Stalin said that theory becomes aimless when it is not connected with practice. Aimless theory is useless and false and should be discarded. (Mao 1975, 40)

Thus, Mao holds that the world has only natural science and social science, which provide, respectively, knowledge of the struggle for production and knowledge of the class struggle. Moreover, natural science as such is useless and should be discarded if it is not applied to the struggle for production; the same holds for social science if not applied to class struggle. From this perspective, there is no place for critical reflection on the downsides or limits of this one-sided approach, a reflection that could draw on broader (moral, spiritual, or religious) values and on other disciplines such as the humanities or philosophy.

Clearly, Mao's 1942 view is even more one-sided and reductionist than that of 1937. Between 1949 and 1978, the Chinese government based its science policy on the two articles "On Practice" and "Rectify the Party's Style of Work." However, in the course of this period, the latter became more influential than the former. As Liangying Xu (1920–2013) puts it, "unfortunately, this relatively complete view (that of 1937) has not attracted enough attention. Rather, the incomplete idea of 1942 became more influential, and the consequences are well known" (Xu 1996, 185). In this situation, science had to satisfy the immediate practical needs of the society and the nation. For instance, in their *Science and Socialist*

Construction in China, published in 1957, Liangying Xu and Dainian Fan (1926-) strongly emphasize that science must serve socialist production and construction and that science is a weapon to fight idealism and religious superstition (Xu and Fan 1982, 55–71). Hence, the sciences discussed in this book are mainly application-oriented sciences, engineering, technology, and production sciences. Furthermore, science had to serve the class struggle and became the handmaiden of politics during the Great Revolution in Proletarian Culture (1966–1976). Therefore, it was required that scientists had to be not only professionally competent but also politically correct.

Mao's view of science was the primary basis for science policy and dominated the development of science before 1978. After Mao, Deng was the actual ruler of China from 1978 to 1997. Deng's view of science was also strongly practice-oriented. In accordance with Marx's account of science and technology, in 1978, he pointed out that science and technology are a part of the productive forces. In his *Capital*, Marx wrote: "This productiveness is determined by various circumstances, among others, by the average amount of skill of the workmen, the state of science, and the degree of its practical application, the social organization of production, the extent and capabilities of the means of production, and by physical conditions" (Marx 2008, 17).

Subsequently, Deng further developed this view. In 1988, he emphasized that science and technology are the primary productive forces. Thus, "science and technology must serve economic development" has been a common and loud slogan in China, because of the absolute authority Deng had since 1978. Before 1978, China took class struggle to be its central task, so science had to serve class struggle. Since 1978, China has taken economic development as its central task, so now science has to serve this development. In both cases, science is practice-oriented, only a practical instrument for direct societal purposes.

In line with the Chinese tradition, Deng does not make a principled distinction between science and technology. However, technology is seen as more directly utilitarian than science. Technology, a direct productive force can be immediately applied to production, in contrast to science as an indirect productive force. It is easy for technology to serve economic development, but it is more difficult for science to do that. Because he always stresses the productive forces and economic development, Deng assigns more importance to technology than to science. In this sense, Deng's view of science is even more practice-oriented than Mao's.

After Deng, Zeming Jiang (1926-), the president of China during the years 1989–2002, developed an equally practice-oriented strategy called "Revitalizing the Nation with Science, Technology, and Education," which is similar to the previous slogan "Saving the Nation through Science." In recent years, guided by the practice-oriented view of science and technology, China has devoted about 5 percent of the total expenditures on research and development (R&D) to fundamental research, 10 percent to applied research, and 85 percent to experimental development of products. By contrast, these numbers in developed countries are, roughly, 15, 25, and 60 percent.[15] This shows that China overemphasizes experimental development and neglects basic research. Today, like before, the one-sided, practice-oriented view of science is rampant in China.

In 2015, Youyou Tu (1930-) received the Nobel Prize in Physiology or Medicine for her discovery of artemisinin and dihydro-artemisinin, which can be used to treat malaria. Tu's research meets the practical needs of the nation and the world. She carried out her work in the 1960s and 1970s in order to develop a new drug aimed at curing malaria. The problem was that in North Vietnam during the Vietnam War, there was a form of malaria that was resistant to chloroquine. Therefore, the Chinese government set up a secret drug discovery project to support North Vietnam, which was at war against South Vietnam and the United States. Tu took part in the project and made a major breakthrough in twentieth century tropical medicine and malaria treatment. Tu's research and great scientific achievements seamlessly fit into the practice-oriented Chinese approach to science.

The Political Grounds of the Practice-Oriented Views of Science in China

As regards the Chinese practice-oriented views of science, dealt with in the preceding sections, Shiping Hua (1956-) writes, "China's scientific development was characterized by: 1) politicization, 2) technologization, 3) downplay of comprehensive theories" (Hua 1995, 19). Among the three characteristics, the second and third, which value technology, engineering, and production, and downplay theoretical work, are indicative of the Chinese practice-oriented views of science. However, they are not on a par with the first characteristic. As Hua (1995, 19) puts it,

> Politicization refers to the fact that science was influenced very much by politics. This is most clearly demonstrated in astrology, because the movement and formation of stars explain the mandate of the Emperor. … New discoveries in astrology were subject to the ruler's political interests. … Technologization of ancient development of Chinese science refers to the fact that those aspects of technology that were useful for the maintenance of the political system were very advanced. China's four big scientific discoveries, paper, the compass, typographic printing, and gunpowder, are examples in point. All these discoveries were closely connected with the central government's desire to control the vast land. None of these discoveries was closely linked with the people's daily life.[16]

In China, politicization and technologization have always played a decisive role in the development of science. The following pattern can be drawn from the above description: politicization transforms the government's practical needs into technology; technologization requires and produces practice-oriented science, not basic science. Therefore, politics determines the practice-oriented views of science in China.[17]

Jin, Fan, and Liu quantitatively researched the structure of ancient Chinese science and technology, especially the relation between technology and politics. They concluded, "we statistically demonstrated that 80% of the cumulative achievements of ancient Chinese science and technology consisted of technological achievements, of which 70% were related to 'unification technologies' and the landlord economy, so that the structure of ancient Chinese technology can be called 'technology of unification'" (Jin, Fan, and Liu 1996b, 165). Here, unification technologies, to which the four great inventions belong, are technologies by which the Chinese governments control and dominate the vast land. These technologies constituted the majority of the technological achievements because the governments needed them. They further needed and advanced application-oriented sciences, but they had no interest in basic science and general theory.

In this way, the development of science in China has been shaped, and impeded, by politics. David Hume (1711–1776) explains why the sciences made so slow a progress in ancient China.

> China is a vast empire, speaking one language, governed by one law, sympathizing in the same manners. … None had courage to resist the torrent of popular opinion. And posterity was not bold enough to dispute what had been universally received by their ancestors. This seems to be one natural reason, why the sciences have made so slow a progress in that mighty empire. (Hume 1994, 66)

Clearly, Hume attributes the slow progress of ancient Chinese science to the unity of language, law, thinking, opinion, and so on, all of which are grounded in politics.

A series of political events that occurred in China from 1949 to 1978 provides more recent examples of how politics controls and determines science. Nianzu Dai (1942-) gives a concise description of how politics affected physics in China during this period.

> Like other disciplines in the natural sciences, physics has constantly been influenced by political events. … The anti-rightist struggle and the three years of natural disaster affected the development of physics both politically and economically. During the ten-year calamity from 1966 to 1976 in particular, almost all physics institutes stopped research and all journals ceased publication. The older generation of physicists were all reproached in one way or another and some were even persecuted to death. … Physicists were forced to leave libraries and laboratories. The process of reeducation

> and "running institutes without walls" prevented physicists from keeping up with developments in their fields. Even worse, during the years when religious superstition ran rampant, astrophysicists dared not study sunspots or observe solar eclipses. (Dai 1996, 217)

The antirightist struggle, the three years of natural disaster,[18] the 10-year calamity,[19] and also the "Movement to Purify Class Ranks" are political events that were launched by the Chinese government. In the course of those events, physicists were forced to stop research and some, such as the founders of modern Chinese physics Qisun Ye (1898–1977) and Yutai Rao (1891–1968), were even persecuted to death. It is striking and shocking that studying sunspots and observing solar eclipses was considered a crime. Mao was compared to the red sun and because he is perfect, the red sun should be perfect, too. Evidently, in China, politics has always been powerful enough to dominate science, even to destroy it. The mentioned political events constitute very good (though absurd) examples of how politics controls science.[20]

Moreover, these events demonstrate an extremely practical attitude to science. According to Zedong Mao's thought, science arises from social practice and in return serves social practice, so science is futile if not applied to production. For this reason, scientists must be integrated with workers and farmers, and must be reeducated by poor peasants. As a consequence, in those years, scientists were forced to leave libraries and laboratories and to go to factories or farmlands, a policy that was called "running institutes without walls." The Chinese government held that scientists could make the greatest contribution to the development of socialism if and only if they labored as farmers or workers.

Furthermore, politics dominates not only science and technology, but also the economy, society, religion, and culture. From his research on China's history and politics, the prominent historian Zehua Liu (1935–2018) draws the conclusion that ancient Chinese society is a power-dependent structure centered on the king's power.

> The king's power dominated all aspects of the society, including the social resources, materials, and wealth. It also dominated agriculture, industry, commerce, culture, education, science, and technology, and the fate of every member of society. In a society ruled by the king's power, all people and materials were to some extent at the disposal of political power. All theoretical or actual care for the people was only a means to political ends. (Liu 2015, 22)

Thus, politics was everything in ancient China. What is more, Chinese politics is everything in all ages.

Adam Smith (1723–1790) attributes the long economic stagnation of China to politics.

> China has been long one of the richest, that is, one of the most fertile, best cultivated, most industrious, and most populous countries in the world. It seems, however, to have been long stationary. Marco Polo, who visited it more than 500 years ago, describes its cultivation, industry, and populousness, almost in the same terms in which they are described by travelers in the present times. It had perhaps, even long before his time, acquired that full complement of riches which the nature of its laws and institutions permits it to acquire. (Smith 1979, 89)

Smith states that China possesses a "full complement of riches which the nature of its laws and institutions permits it to acquire." That is, the nature of laws and institutions determines the economic development in China. Since its laws and institutions belong to politics, it is politics that determines the Chinese economy. This conclusion goes against the Marxist idea that the economy determines politics. In China, it is emperors and statesmen who rule.

Why does politics play such a decisive role in China? We think that three political events are the primary reasons. First, emperor Shi Huang Di of the Qin Dynasty established the system of prefectures and counties to replace the old system of feudal fiefs. It transformed China into a strongly centralized state power, with one man at the top. Nobles disappeared and were replaced by bureaucrats. An emperor possessed all political power. The second political event is the campaign of "burning books and burying Confucians alive," launched by Shi Huang Di in order to consolidate his new regime. It made the emperor the only thinker. Common people were prohibited from thinking and had to take emperors and officials as their only teachers. Third, the Han emperor Wu Di (156–87 BCE) rejected the hundred schools of thought and worshipped only Confucianism. This further contributed to a unity of thinking. From that time until 1911, Confucianism was the orthodox ideology of China, and other ideologies were restricted or prohibited, although Confucianism (similar to a religion) was dependent on and served the state. In sum, these three events discouraged the Chinese from being open-minded, critical, and freely creative.

After those political events, China accomplished a unification of the state and the church, because Confucianism could be considered as a religion.[21] The state dominated the economy, society, science, technology, philosophy, and also religion. The state was powerful enough to eradicate viewpoints and theories it did not approve. As a consequence, science became the handmaiden of politics in China. For instance, the event "burning books and burying Confucians alive" implied that politics should be realistic and practical, and the same should hold for science.

Many people assume that the first emperor of the Qin dynasty ordered the burning of *all* books.[22] However, that is not true. According to the *Records of the Historian* by Qian Sima (145–90 BCE), emperor Shi Huang Di sanctioned the proposal of his prime minister Si Li (c. 284–208 BCE) for burning books. Li clearly proposed which books should be delivered to the government and be burned.

> Li said "I humbly propose that all historical records but those of Qin be burned. If anyone who is not a court scholar dares to keep the ancient songs, historical records or writings of the hundred schools, these should be confiscated and burned by the provincial governor and army commander. … The only books which need not be destroyed are those dealing with medicine, divination and agriculture". (Sima 2010, 18–19)

Therefore, the order applied only to books from humanities, social sciences, and religions, but not to those from natural sciences, especially from application-oriented sciences, which included medicine, pharmacy, divination, astronomy, agronomy, and arboriculture. The Qin court burned books from humanities, social sciences, and religions to suppress dissent and seek a unification of thought, but it protected those about practice-oriented sciences and technologies for the purpose of developing the economy.[23] Its ultimate goal was to consolidate its regime. It used science and technology as a practical tool to serve the state. While humanities, social sciences, and religions may create viewpoints and theories that are inconsistent with the ideology of the state, natural science, especially application-oriented science, and technology can serve the state and social practice as a utilitarian instrument. Hence, Si Li and the First Emperor seem to endorse the claim that "science and technology are the primary productive forces," pointed out by Deng. The Chinese governments have always valued science and technology, but belittled or eliminated the humanities, social sciences, and religions.[24] As Xi puts it,

> any fairly stable or enduring regime in China did something in favor of scientific development. Even Emperor Qinshihuang, notorious for burning unorthodox books, spared books which dealt with medicine, divination, and tree-planting. In addition, he mustered more than 300 scholars to conduct astronomical observations and meteorological surveys. No monarch could afford to ignore scientific progress if he wanted to maintain lasting political stability. (Xi 2001, 99)

Max Weber (1864–1920), the German sociologist and philosopher, argues that in ancient China, politics (bureaucracy) resulted in a practical rationalism that did not lead to any further rational science and technology. He writes:

> Under the conditions of patrimonial bureaucracy, the contest of the ruling stratum was discharged entirely into competition among prebendary and degree-hunting literati and all other pursuits were stilled.
>
> Consequently, practical rationalism, the intrinsic attitude of bureaucracy to life, free of all competition, could work itself out fully. There was no rational science, no rational practice of art, no rational theology, jurisprudence,

> medicine, natural science or technology; there was neither divine nor human authority which could contest the bureaucracy. (Weber 1959, 151)

According to these two passages, the bureaucracy, which neither human nor divine authority could contest, dominated and controlled China. Under the conditions of patrimonial bureaucracy, only practical rationalism remained, and all other rational and spiritual pursuits were stilled. Practical rationalism, the intrinsic attitude of bureaucracy to life, was free of all competition. Therefore, there were practice-oriented sciences and technologies but no basic science and no science-based technology.[25] In short, it is because of this bureaucratic politics that the attitude to science is practical.

At the time of Mao, the political system was a totalitarianism with Chinese characteristics. In the 1960s, China developed atomic bombs, hydrogen bombs, and missiles, in line with the systematic intervention of politics in science and technology. During the Great Revolution in Proletarian Culture, Youyou Tu isolated artemisinin from a plant and synthesized dihydro-artemisinin, while almost all other scientific institutes stopped research and universities were closed. The projects in the area of applied research could be successful because they were funded and organized by the Chinese government and because they satisfied its political and utilitarian needs. As Cong Cao puts it, "in this context, science, including the pursuit of the Nobel Prize, is more a pragmatic means to achieve the end of the political leadership" (Cao 2014, 142). For instance, Mac Lane (1909–2005) investigated the Chinese mathematical journal *Acta Mathematica Sinica*. The journal stopped publishing in July 1966 and reappeared in 1973 (so, it is incomplete for the year 1966). Mac Lane compared the 1966 counts of mathematical topics with the corresponding counts covering the 1974 and 1975 issues, and drew the following conclusions:

> We note that every topic has diminished except for the relatively practical topic of differential equations. (Mac Lane 1980, 77)

> All added topics (perhaps except for history) belong strictly to the applications—and these publications on the applications are in addition to those in the new journal *Mathematics: Its Cognition and Practice*. The contents of the latter journal in 1975 and 1976 are strictly immediate-type applications. (Mac Lane 1980, 78)

Clearly, Maoist totalitarianism made Chinese mathematics even more practical during the Great Revolution in Proletarian Culture. It destroyed basic mathematics and only encouraged applied mathematics, thus emphasizing the utility of mathematics.

A totalitarian, state-dominated system always advocates a practice-oriented view of science, because it gives preference to application-oriented science and technology. The former Soviet Union, for example, could not compare with the United States in the area of fundamental research, but they were evenly matched in the area of applied research. This kind of politics invariably results in a practice-oriented approach to science.

Conclusion

In China, the views of science from ancient times to the present are strongly practice-oriented because science has been the handmaiden of politics since the Qin Dynasty. It is politics that dominates science and controls its position and function. Science has to serve the governments and meet their immediate practical needs. Accordingly, the practical approach to science is grounded in politics. This does not mean, of course, that each and every facet of scientific practice can be explained solely by its relation to the state. But what it does say is that state domination has been and continues to be a very strong and normatively relevant *nonlocal pattern* in the history of Chinese science.[26]

Furthermore, we do not question the fact that science and mathematics have always been, in various ways and to various degrees, related to technology. Our criticism of the Chinese practice-oriented views of science applies to the extreme reductionist claim that only technological sciences, and not basic sciences and humanities, possess social relevance. Our argument against this reductionist claim is that a science that is limited to dealing with contemporary economic and societal issues lacks the conceptual, epistemic, and technical resources that provide the best chances for addressing unforeseeable future challenges.[27] Moreover, as a matter of fact it is often basic, rather than practice-oriented science that promotes openness for critical debate on the broader implications and meaning of science, including its relationship to religion. Therefore, a country that lacks well-developed basic sciences also lacks the cultural resources for a mature debate on the possible downsides and limits of a purely technoscientific approach.

Nowadays, the practical attitude to science, which is taken for granted by the government and the people, is rampant in China. However, this attitude hinders the development of science, especially basic science. Therefore, China should change its view of science and attach greater importance to basic science. Only on this condition, is it possible for science to become independent of direct interference by politics. Since the Qin dynasty political power has been so strong that it will not be easy to decrease this direct political intervention in science. However, it may be possible by pursuing and developing democracy, freedom, and constitutionalism, by abandoning the one-sided scientistic doctrines, and by supporting sustained critical reflection from a more pluralist range of values.

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Notes

1. Presently, the English word "science" is translated with the Chinese characters *Kexue*. In ancient China, these characters denoted the knowledge or the schools of the imperial civil service examination system (*Keju*). From the beginning of the seventeenth century, when the Jesuit priests came to China, until the early twentieth century, the English word "science" was translated with the Chinese characters *Gezhi*. The Japanese translated it with the Japanese characters 科学 in the 1870s. After the Sino-Japan War of 1894–1895, in which China was defeated by Japan, Chinese scholars who followed the Japanese began again to substitute *Kexue* for *Gezhi* when they translated "science" into Chinese. Therefore, *Kexue* has been the translation of "science" since about 1905. For a more detailed study of basic terms such as "science," *Kexue* and *Gezhi*, see Jin and Liu (2012).

2. In this article, we use this term in the sense of "primarily oriented towards technology and other practical uses" (thus excluding the "practices of basic science").

3. At present, the historical textbooks of China divide the Chinese history into the ancient period (before the Opium War of 1840), the early modern period (from 1840 to 1949), the late modern period (from 1949 to 1978), and the contemporary period (from 1978 to the present). They divide the European history into the ancient period (before 476), the Middle Ages (from 476 to 1453), the modern period (since 1453), and the contemporary period. Contrasted with European history, Chinese history lacks a period like the European Middle Ages, which were characterized by the dominance of Christian faith. To be sure, in China, the people had to believe in Confucianism as the official faith or ideology of the state from 134 BCE (when the Han emperor Wu Di, who reigned 140–87 BCE, made Confucianism the orthodox ideology of the Han Dynasty, at the expense of the other ideologies) until the 1911 Revolution. However, although China did not keep Confucianism and government separated, it was government that controlled Confucianism, and not the other way around. In sum, in China the "Middle Ages" lasted much longer (over 2,000 years) than in Europe (less than 1,000 years). Youlan Feng (1895–1990), a well-known Chinese philosopher, divides the history of Chinese philosophy in the period of schools and the period of classics, the latter corresponding to the Chinese Middle Ages (Feng 2006).

4. For "philosophy as the handmaiden of religion and politics," see Matthews (2015, 358–61). In 2016, *Zygon: Journal of Religion and Science* (vol. 51) published an instructive special section on "Voices from East Asia," including some articles about science, religion, and the humanities in China. Some other valuable articles (e.g., Li and Zheng 2015; Wong 2015) also deal with this topic. In contrast to these articles, our focus is on the neglect of basic science, on its political grounds, and on its consequences for open-minded and critical debate on the relation between scientific and broader (moral, spiritual, or religious) values.

5. "There was no science in ancient China," writes Shuming Liang (1893–1988), a leading Chinese scholar (Liang 2016, 254). However, if we carefully read the book, we see that his real point is that "there was no basic science in ancient China." He claims that there were arts of healing, agriculture, and horticulture (application-oriented science and technology), but no botany, no physiology, no pathology, and no anatomy (no basic science). Therefore, he argues that the pursuit of knowledge was not for its own sake but for solving problems of practical life in the world of ancient China (Liang 2016, 254–62).

Guosheng Wu (1964-) includes geography (in addition to agriculture, astronomy, medicine, and pharmacy as natural history) among the most significant sciences in ancient China (Wu 2016, 293–302). Instead of mathematics, he emphasizes geography. In contrast, we maintain that in ancient China, mathematics was more important, useful, and primary than geography.

6. Zezong Xi (1927–2008) is a well-known historian of science in China. His view seems to differ from ours. He writes: "Another frequently raised objection is that the Chinese are only versed in practical application while completely neglecting basic research. This is not true either" (Xi 2001, 99). He lists evidence from the fields of mathematics (the calculation of the ratio between a circle's circumference and its diameter), physics (optics in *the Mohist Canon*), chemistry (alchemy recording the reactions of substitution in chemistry), and biology (arboriculture, agronomy, breeding animals, and planting crops). However, with the exception of the calculation of π, which was used in astronomy and engineering, these are all application-oriented sciences.

7. Needham (1959, 25–27). In this book, Chinese names are spelled in the Wide-Giles Spelling System, which was popular before 1958. However, in the same year, the Chinese government published the Pinyin Spelling System, the Chinese phonetic alphabet, which has been used and popularized since then. Therefore, we have converted Chinese names from Wide-Giles to Pinyin. In this article, we do so wherever quoted Chinese names are spelled in the Wide-Giles Spelling System.

8. In the Sui and Tang Dynasties (581–907), the 10 official mathematical textbooks were the following: *The Gnomon and Circular Path*, *Nine Chapters on the Mathematical Art*, *Sea Island Mathematical Manual*, *Master Sun's Mathematical Manual*, *Qiujian Zhang's Mathematical Manual*, *Mathematical Manual of the Five Government Departments*, *Continuation of Ancient Mathematics*, *Yang Xiahou's Mathematical Manual*, *Five Classics on the Mathematical Art*, and *Art of Mending*. By the time of the Song Dynasties, *Yang Xiahou's Mathematical Manual* and *Art of Mending* had been lost, so they were replaced by two other mathematical books.

9. For more details, see Zhang (2015, 256–57).

10. The "skill of killing dragons," which originated in a Chinese fable, means a skill that lacks any opportunity for use.

11. For more details, see Zhang (2015, 148–49).

12. It is also known as the Self-Strengthening Movement.

13. For Saving China through Science, see Wang (2002).

14. For the practice-oriented views of science in the Marxist tradition, see Skordoulis (2007). In addition, for Marxism and the practice-oriented views of South-China high school students, see Deng et al. (2014). The relation between Marxism and the philosophy of science and technology is discussed in more detail in Guo (2014).

15. Dalian Technological University, *The Report on Chinese Funds for Research and Development (2018)*, https://www.360kuai.com/pc/95f8032a20eefc2ee?cota=4&tj_url=so_rec&sign=360_57c3bbd1&refer_scene=so_1.

16. By calling the four big discoveries, *scientific* Hua does not distinguish technology from science, as many Chinese do.

17. In 2007, the journal *Isis* published a special section on "Science and Modern China." Although these articles include relevant discussion of the role of the state and of the practice-oriented view of science in modern China, their main aim is to advocate a global and comparative approach to the historiography of twentieth-century Chinese science (see Elman 2007). In contrast, our focus is on the practice-oriented views in ancient, modern, and contemporary Chinese science and on the question of whether, why and how politics dominates these views.

18. The three years of natural disaster refer to the Great Leap Forward, which took place from 1958 to 1961.

19. The 10-year calamity from 1966 to 1976 refers to the Great Revolution in Proletarian Culture.

20. A detailed case study about seismology in Mao's China shows how the Chinese government controlled this research, which had to meet politically practical needs, thus confirming that the Chinese practice-oriented view of science was shaped by politics (Fan 2012).

21. Whether Confucianism is a religion has been disputed. For example, Na Chen argues that, in contemporary China, Confucianism should not be seen as a religion (Chen 2016). However that may be, in the context of this article the relevant point is that Confucianism was dominated and controlled by the government.

22. For example, Victor Katz (1942-) writes: "legend holds that this emperor ordered the burning of *all* books from earlier periods to suppress dissent" (Katz 2004, 116–17).

23. The "July 21 directive" by Mao is similar. On July 21, 1968, Mao ordered that China should run only colleges of natural science, technology, and engineering, and should eliminate

departments of social science, humanities, and religious studies; that politics should dominate Chinese universities; that students selected from workers and farmers should return to factories or farmlands after finishing their studies (Mao 1968).

24. As we have seen in the previous section, in 1942, Mao still accepted social sciences, albeit only in the restricted sense as an instrument for class struggle.

25. As Hongsheng Wang (1954-) puts it, "in traditional Chinese civilization, knowledge and technology were to a large extent controlled by political culture. Science and technology appeared only because of their application values; academic rationality in traditional civilization is just a sort of ornament" (Wang 2014, 129).

26. Nonlocal patterns may have a far-reaching historical meaning and impact, even if they do not determine historical developments in each and every detail. For the role of such patterns in historical and sociological explanation, see Radder (1996).

27. For detailed discussion of the theoretical, empirical, and evaluative aspects of this argument, see Radder (2019, chapters 6 and 7).

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