

Major Themes in Economics

Volume 3

Article 5

Spring 2001

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Recommended Citation

Gernes, Matthew (2001) "China: Unfulfilled Promise," *Major Themes in Economics*, 3, 35-52.

Available at: <https://scholarworks.uni.edu/mtie/vol3/iss1/5>

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China: Unfulfilled Promise

Michael Gernes

ABSTRACT. At the turn of the first millennium A.D. the Chinese empire was perhaps the most technologically and economically advanced civilization on the planet. Economic historians continue to wonder why China stopped progressing along a path which seemed to promise an industrial revolution similar to that experienced by the West. This paper examines how the social and political institutions which made pre-industrial China different from Europe may have prevented such a revolution from happening. The imperial bureaucracy, Confucian philosophy and the centralized nature of the empire all played a role in preventing China from escaping the pre-modern world until the 20th century.

I. Introduction

The year was 1841. Britain had recently declared war on the Chinese empire to defend the right of her merchants to sell opium to the Chinese people in exchange for the tea which the British craved. To historians, this conflict became known as the first Opium War, but much more was at stake than just the Asian drug trade [Headrick, 1981, 44-46].

For the first time, a European power had directly challenged the power and authority of the Celestial Empire, as China referred to itself. Since the 16th century, European merchants had sailed to China to humbly petition and sometimes beg the Chinese for the opportunity to trade for the silks, spices and other goods which Europe wanted [Landes, 1998, 334-339]. The Chinese court and the Chinese emperor (the Son of Heaven) had given audiences and entertained these visitors, but had never completely opened the empire up to the European trade requests. Apart from a few small trading enclaves like Macao, which had been given to the Portuguese, China was a closed society [Elvin, 1973, 215-229].

The latest Europeans to be turned away were the British missions to China under Lord Macartney in 1793 and Lord Amherst in 1813 [Headrick, 1981, 44]. The British, aware of their power at sea and their growing technological domination, were tired of begging. By 1841, a fleet of wooden-hulled British men of war lay off the Chinese coast. Up to this point in history, China had been virtually invulnerable to attack from the European “barbarians.” Europe’s strength was in its navies, and no sailing ship could make it up the Yangtze delta. Even if they could, China had an enormous army [Headrick, 1981, 43].

The industrial revolution had changed the rules, however. Armed British steamboats towed the larger sailing ships into position to attack the stone-walls of the “Bogue” forts protecting the entrance to the Pearl river at Canton. The warships’ powerful lanyard-operated guns raked the forts, and British marines stormed ashore, some of them armed with the latest percussion-cap muskets which fired even in the rain. They received fire support from the gunboats, which were able to steam close inshore and bombard Chinese boats and troops with rockets and rifled cannon [Headrick, 1981, 49-54].

The Chinese soldiers defending the world’s greatest (and once richest) land empire fired cannon cast two centuries earlier from behind the old-fashioned straight stone walls of their forts. They were armed with swords and pikes and wore armor and shields made for an earlier day. The luckier troops carried gingals, rudimentary muskets mounted on tripods which required two men to operate. Chinese war junks were one tenth the tonnage of the British ships of the line; most hung back in the river mouth. Some of them fired cannons, but others attempted to close with the British and fling burning pots of pitch onto their ships. They were crushed or captured [Headrick, 1981, 49-54].

Within a year, the British fleet had forced its way into the network of canals which China depended on for its internal grain transportation. It was checkmate for the Celestial Empire. The British imposed terms often described as humiliating upon a once-proud civilization and the drug trade continued [Headrick, 1981, 49-53].

The terrific irony is that things did not *have* to happen this way. Picture this story from the opposite perspective: the forces of the Chinese navy sailing up the Thames river and laying siege to London sometime during the 18th century. Although it wouldn’t have happened, since Britain would never have been a great prize to the Chinese, it could have. Eight centuries before the Opium War, it was China which led the world in nearly all fields of technology and was the richest nation on the planet.

Many scholars believe that China could have become industrialized as early as the 14th century, yet the empire did not [Mokyr, 1990, 218-219]. So why didn’t this happen? Why did China fall behind Europe when it seemingly had all the advantages?

Technological slowdown and lethargy seem to be the main reasons. What happened to the rate of invention and innovation in China when this would have made possible the capital improvements underlying an

industrial society? Why didn't the Chinese make use of the potentially labor-saving inventions that their tinkers and savants came up with? These are very important questions. They have everything to do with how correct economic theories about long-term macro-economic growth are. They also has to do with the role that socio-political institutions play in that same economic growth. Finally, it has to do with technology, which economists believe to be the driving factor behind the modern world's ability to keep productivity ahead of population growth.

Hard answers are extremely elusive, but they seem to lie in the very institutions which defined the Celestial Empire. The Chinese bureaucracy and worldview which provided stability and longevity to Chinese civilization may also have held the seeds of China's ultimate failure to meet its early promise. There is little certainty here, but certainly both were very important factors.

II. A Background in Chinese History

THE FABRIC OF CHINESE CIVILIZATION

To discuss Chinese civilization in an economic context it would be desirable for the reader to have at least a rudimentary background in the subject. It is impossible to encapsulate the complete tapestry of Chinese history in just a few pages. Unfortunately, space constraints require that I focus on a few points where Chinese civilization relates to economics.

The basic elements of what we today call "China" started to come together during the Chinese iron age, coalescing during what historians call the Warring States period [Roberts, 1999, 7-8]. As the name implies, the era was characterized by warfare between what were essentially independent kingdoms. They had once been loosely knit together by the ancient Zhou kingdom, a bronze age civilization which had lasted from 1122 BC to 256 BC.

The Zhou order had deteriorated during its Spring and Autumn period (which is named after *The Spring and Autumn Annals* written around that time). The iron age had arrived in China during the Spring and Autumn period, but the spread of iron technology came to full fruition during the Warring States period. This resulted in dramatic changes in China. The spread of metal tools and fertilizer techniques in agriculture and growth in trade brought an increase in economic output

and allowed China to support specialist classes and for states to become more organized. [Roberts, 1999, 12-13].

War in the earlier Zhou period had been an activity for an elite nobility who were often mounted on chariots, which were the pre-eminent war machine of the bronze age. In the Warring States period, wars were fought by large armies (some as large as 600,000) made up of infantrymen who were conscripted into service by the state.

These armies were armed with the latest weapons of the day, including the crossbow (a weapon not to be seen in Europe until hundreds of years later), iron swords and armor. These armies were often led by professional generals like Sun Tzu, who wrote his famous *Art of War* during the fifth century BC [Roberts, 1999, 13-15]. The patterns laid down here would continue to characterize warfare throughout the rest of pre-modern Chinese history.

The Warring States period and its political climate also gave birth to one of the most vital and enduring components of Chinese civilization. A government official in the northeastern state of Wei named Kong Fuzi (known as Confucius in the west) came to hold the conviction that these were troubled times requiring enlightened government. He believed these principles could be found in writings about the leaders of the early Zhou period, which he regarded as a golden age [Roberts, 1999, 14].

Confucius thought the Zhou leaders had “followed the *tao*, or Way, which in this context meant the Way of running a state so that good order and harmony can prevail among men” [Roberts, 1999, 14]. In addition to ruling with benevolence and promoting the general welfare of the people, Confucius felt that leaders should strive for the ideal of the well educated, self-cultivated “gentleman.” He also stressed the importance of “filial piety,” or respect and duty to one’s family, especially one’s elders. Over the course of his life, his teachings attracted a devoted following who collected his sayings after his death, compiling them in the first work of Confucian literature: the *Analects* [Roberts, 1999, 14-15].

Confucian thought became codified in the following three centuries and a body of literature began to emerge which formed the basis of classical Chinese education. It included not only writings attributed to Confucius, but writings from the Shang and Zhou periods (including *The Spring and Autumn Annals*) and works regarding classical Chinese cosmology like the famous book of divination, the *I Ching* [Roberts, 1999, 18-19]. Confucian philosophy, however, would not be the only strain of thought to come out of or affect China.

Taoism was the second major school of philosophy to emerge from the time of the Warring States. The *Lao Tzu*, which was written in the fourth century BC, lays out its major ideas. *Lao Tzu* is a compilation attributed to a semi-mythical writer of the same name, who current historians think may never have existed [Roberts, 1999, 16-17].

Taoism was focused on the concept of “the Way” mentioned by Confucius, but the two philosophies were very different. In Taoism, the absolute is knowable not through logic, but through intuition. Taoism’s central tenet is to surrender to the Tao and let it act through oneself. This is called *wu wei*, which is best translated as “not doing” [McCormick, 1999].

Like Confucianism, Taoism also addressed the subject of good government. Taoism advocated that the best rulers were those who interfered the least and instead let the Way determine the natural outcome of things. Historians of economic thought have often noted Taoism’s remarkable *laissez faire* implications, so many centuries before Smith [McCormick, 1999]. What course might Chinese history have taken had Taoism become its dominant philosophy? Unfortunately, the question is moot, since it was Confucian philosophy that won out in the long run. Confucianism came to act as the “glue” which defined Chinese civilization and bound it together, though the *Mencius* (a work reiterating many Taoist concepts) did become a part of the Confucian canon [Roberts, 1999, 18].

The Warring States period closed with another milestone for Chinese history: the unification of China under the first emperor, Qin Shi Huangdi. The name “China” comes from the name of this first imperial dynasty, the Qin or “Chin”. The Qin dynasty came from the kingdom which finally conquered the other warring states in the 220’s BC. The Qin economy was strengthened a century earlier by reforms which gave it a free market in land usage, boosting agricultural output and the wealth of the state. This advantage, combined with skilled warcraft and the ability to raise large, well organized armies allowed the Qin to crush all opposition within a few decades [Roberts, 1999, 18-22].

Li Si, the emperor’s chief advisor, initiated reforms based on Legalist philosophy. Legalism was a school of thought in opposition to Confucianism; it advocated that good leaders should direct their policies for the good of the state, not the people. Li Si attempted to standardize weights, measures and to build roads. Despite these actions, the Qin dynasty was damaged from its start by the emperor’s execution of

hundreds of Confucian scholars who had criticized him. These scholars were already forming a growing intellectual elite within China, and this action helped hasten rebellions against the dynasty's authority [Roberts, 1999, 22-26].

After his death, Qin Shi Huangdi was buried in a magnificent funerary complex. When parts of this tomb were excavated in the 1970's over 7000 life-size terra-cotta soldiers were found in pits, as well as a jade-plated burial suit intended for the emperor. The first emperor's dynasty collapsed just a few years later under peasant-led rebellions, having lasted barely a generation. Liu Bang, one of the peasant generals who had rebelled against the Qin, was able to take the imperial throne, styling himself *huangdi* (sovereign emperor) and taking the name Gaozu [Roberts, 1999, 25-27].

The Han dynasty which Liu Bang founded came to define the Chinese imperial system which continued off and on for the next two-thousand years. It was claimed that the emperor held the "mandate of heaven" (a concept dating as far back as the Zhou period) as justification of his dynasty's reign. Its bureaucracy was composed at least partially of Confucian scholars or Confucian-educated noblemen to administrate the empire. Finally, its economy was

[Based on] intensive cultivation involving sophisticated techniques of irrigation and seed selection; an economic interdependence in which a free peasantry produced a marketable surplus of primary goods, and supplemented its income through domestic handicrafts; and an economic vulnerability to natural disasters and the encroachment of landlordism and state exactions. [Roberts, 1999, 29].

As a land empire, China would be harassed throughout its history by horse-riding tribesmen from the central Asian steppe. During Han times, this threat was posed by a group known as the Xiongnu. It was extremely hard for the infantry-based armies of the Chinese to decisively defeat the horsemen, who could always retreat back into the steppe for refuge. Some of these horse tribes even came to rule part or all of China at different times (Roberts, 1999, 28-30). This contributed to the "dynastic cycle," one of the main recurring themes in China's history.

In the dynastic cycle, a new family rose to the throne, as the Han did, through able leadership during the times of rebellion and unrest

which marked the previous dynasty's fall. Over time, the new dynasty unraveled due to its own problems, rebellions increased again, and another family took the mandate of heaven. The Han dynasty did not completely disintegrate for four centuries, lasting from 206 BC to 220 AD (Roberts, 1999, 28-30).

Han China is often compared to the world's other great iron age civilization: Rome. According to J.A.G. Roberts:

Both empires extended to the limits of the known world, both recorded remarkable technological achievements, both developed sophisticated administrative and legal systems, and both enjoyed a similar span of power until their collapse. Similarities have also been found in the explanation for their fall: the rise of privileged families owning vast estates; the degeneracy of the imperial line and factionalism at court; and an ideological failure, precipitated in the Roman case by the rise of Christianity, in China by the attraction of popular Taoism. Both empires were threatened by 'barbarian' tribes on their frontiers and both made the fatal error of allowing these 'barbarians' to settle within their boundaries [Roberts, 1999, 39].

Roman civilization was replaced by Germanic tribes who became Christianized, giving birth to medieval Europe and its institutions, leading eventually to the modern western world. It took centuries for classical Greek and Roman writing and philosophy to be rediscovered and popularized in Europe, and then only what had survived in religious monasteries. However, classical Chinese civilization-as embodied by Confucian literature and the imperial institution-never really went away. Each time the imperial system broke down it eventually came back together [Roberts, 1999, 39]. This is seen as the great strength of Chinese civilization but ironically, as it will be shown, it was also perhaps its undoing.

The empire was effectively dissolved from 220-589 AD during what is called the Period of Division. Independent kingdoms with ever-shifting borders controlled different parts of China and separate dynasties ruled the north and south during the latter half of this period. In the late 6th century, the Sui dynasty (quickly replaced by the Tang in the early 7th

century) reunited the Celestial Empire, as China had become known (Roberts, 1999, 40-48).

It was during Tang times that Chinese culture spread throughout east Asia to countries like Korea and Japan (a country which had only recently turned to agriculture from hunting and gathering). The Chinese pictographic writing system and Confucian literature became a shared cultural heritage in these countries, giving rise to the historical label of the “East Asian Cultural Sphere” for this situation (Roberts, 1999, 66-69). The Tang dynasty lasted from roughly 617-906 AD but its accomplishments are outside the scope of the larger discussion of China’s divergence from the West. so we will skip forward a bit, to reach the meat of our discussion.

UNFULFILLED PROMISE

The period of division following the disintegration of the Tang lasted only half a century. In the 960’s AD, the Song (or Sung) dynasty emerged under a usurping general who had been employed by the last of the five dynasties which had ruled north China during the interim. Under the Song, China would take some of its greatest technological and economic strides, far outdistancing those of Europe, which was still a backwater of the world, compared to the lands of Islam and China. It has been said that an impartial observer of the Earth’s peoples, picking a “winner” at the turn of the first millennium AD would have overwhelmingly chosen China, due to its leadership [Roberts, 1999, 83-84].

Politically, the Song confirmed the examination system begun under the Tang as the most important entrance into the imperial bureaucracy, though the purchase of office or family connection still remained another avenue for entry. Under this system, candidates for office were required to pass a rigorous examination in Confucian philosophy in order to qualify for acceptance into the bureaucracy. The degree they earned on the examination determined their rank. This would prove to be an important step, for it may have initially helped China’s progress, providing a pool of administrators many of whom were intelligent and learned.

These bureaucrats became known as “mandarins” and the bureaucracy became referred to as the mandarinat, at least in western sources [Roberts, 1999, 85-88].

The great economic change during the Song dynasty primarily took the form of increased agricultural output. This growth in output came from three intertwined sources. First, there was a vast shift in population from north to south China. Second, this demographic change was coupled with a change in the Chinese staple crop from the wheat and millet grown in the northern plains toward rice agriculture, for which southern China was well suited. Third, a substantial amount of technological diffusion in agriculture increased the productivity of farmers as well [Elvin, 1973, 113-130].

The growth in rice cultivation in the south made it an especially receptive time for a leap in productivity. Wet-field rice agriculture is a capital-intensive activity by its nature. Rice-growing in Southern China has a drier climate than southeast Asia and rice-growing required the construction of wet “polder” fields, continual irrigation and large amounts of manure. The invention of better hydraulic capital-devices such as the *noria* (a water-wheel with clay pots at the periphery) and the moveable pallet-pump translated into increased productivity [Elvin, 1973, 113-130].

There was also an end during Song times to the Tang dynasty’s attempts to enforce the “equitable field system” of land distribution, in which the government distributed public land to the peasantry. A “free” market in land usage gradually replaced this system, and large agricultural manors became the norm in much of the country. According to economic historian Mark Elvin, this system of “manorialism without feudalism” was not universal in China but was widespread in the rice-growing south, probably because only large manors could afford the necessary capital improvements [Elvin, 1973, 73-82].

An interesting side-note is that the growth of manorial systems in both Europe and Japan resulted in the development of a professional warrior class to protect the manor. In Europe these were the knights; in Japan, the samurai. These classes tended to usurp political power and impose a significant amount of inefficiency on their societies, which was especially true in Japan under the Tokugawa shogunate. This did not happen in China, where central authority was never replaced by true feudalism, which leaves one to wonder again why China ultimately lost its lead over Europe. However, as we will see later, there seem to be some advantages to the disunity which accompanies feudalism.

In addition to agricultural growth, Elvin also identified improvements in water transportation both at sea and in a system of internal canals completed during the Song dynasty. There was a great

increase in the supply of copper, and with it the availability of currency for market transactions. Money lending also increased, allowing easier capital flows for investment and commercial ventures. Market activity, internal trade and regional specialization developed to an unprecedented scale, probably due to the increased ease of water transport which linked rural and urban areas [Elvin, 1973, 113-199; Roberts, 1999, 87-88]. Finally, Elvin (and many other scholars) have noted the incredible amount of technological invention going on in China, centuries ahead of the rest of the world in many cases.

Joel Mokyr, a technological historian, compiled a lengthy list of “precocious” Chinese inventions during the Tang, Song and Yuan dynasties. Included are the agricultural inventions already mentioned but there is much more: magnificent water clocks constructed during the tenth and eleventh centuries; advanced sailing technologies, including better ship design, navigation methods and sails; the use of gunpowder in rockets, catapult bombs and possibly even firearms; mine drilling; porcelain; the use of the blast furnace in iron production (a full thousand years before Europe); and printing. This is just an incomplete list, but it gives the reader an idea of just how far ahead the Chinese were, technologically and economically, at the start of the first millennium [Mokyr, 1990, 209-218].

Technological invention and diffusion still continued after the Song dynasty declined and fell to another wave of steppe horsemen. First, the Jurchen Jin conquered northern China in the first quarter of the 12th century which split the country in two, though the Song still ruled in the south. A century later, Ghengis Khan and the Mongols destroyed the Jin dynasty and swept into southern China a generation afterward under Ghengis’ grandson, Khubilai. In the process, the Celestial Empire became a part of the enormous land empire the Mongols created, which covered virtually all of mainland Asia and parts of the Middle East and eastern Europe [Roberts, 1999, 94-109].

Khubilai adopted the role of Chinese emperor in addition to his position as *khaghan* or “Great Khan” of the Mongols. The Mongol reign over China is known as the Yuan dynasty and lasted a little over a century and a quarter. Zhu Yuanzhang, the man who became the first Ming emperor, came from peasant origins to lead rebel bands during the a wave of rebellions at the end of the Yuan dynasty. He took advantage of the breakdown of Yuan control created by declining Mongol fortunes in

China and across Asia and seized the throne in the 1360's [Roberts, 1999, 119-122].

A REVERSAL OF TRENDS

It is now that the story of China changes dramatically. There is no set demarcation line where the growth in productivity under the Song and Yuan "ended," but the pace of China's technological (though not economic) growth gradually slackened and finally stopped altogether. It happened at some point during the Ming dynasty and persisted during the Qing (Ching) dynasty which replaced it in the 1640's. Europe and China began to diverge after the Industrial Revolution, and by the early 19th century the gap between east and west was glaring [Landes, 1998, 344-346].

Growth in the Smithian sense continued. China was filling up in population and intensifying against fixed land and resources and there was no accompanying change in productivity to "save the day" [Elvin, 1973, 298-316]. This took centuries, to be sure, but eventually China turned off the path of a vigorous and proud empire ahead of its time onto a road of increasing poverty and overcrowding. It was a situation ripe for the predatory ambitions of the imperial European powers who had grown tired of sending ambassadors to be condescended to by the imperial court and who had grown powerful with their new armaments and tools [Landes, 1998, 335-340].

II. Why Did China Fall Behind?

Answers to the perplexing question of China's divergence from its own promising future and from the West are hard to come by. However, there are plenty of recurring themes among the theories which scholars have developed to explain this problem. Untangling the threads of causation is the difficult part.

More than anything else, the institutions of the Celestial Empire seem to have created a number of problems for the emergence of western style "capitalism" in China and for technological invention similar to that seen in industrial Europe. Though they lent Chinese civilization a certain durability, they ended up bogging it down as well. In short, the imperial institution was to blame, starting with the bureaucrats.

According to Joel Mokyr, technological change in China even at its height was largely a top-down process:

In the great agricultural expansion of the Middle Ages, government played a central role in the coordination of hydraulic projects and the dissemination of technical information. Officials wrote and published books on farming and promoted the adoption of faster-ripening and more drought-resistant strains of rice... Wang Chen and Hus Kuang Chhi, the authors of massive treatises on farming, were government bureaucrats. As early as the Han period (221 BC to 220 AD) the government provided peasants with the capital they needed for agricultural improvements, including tools and draft animals... A millennium later, the Sung [Song] government offered financial incentives to farmers to invest in improvements... the government also played a major role in the development of transport technology and the diffusion of medical knowledge [Mokyr, 1990, 233-234].

So the government would promote the sort of internal improvements that would bring increased tax revenue or internal trade. However the imperial system might be interested in technical improvement to a certain point but it would not tolerate the upheaval associated with major inventions and their accompanying innovation [Mokyr, 1990, 232].

To Mokyr and other scholars, Europe was too fragmented for any one state to have “market power” over ideas. Persecuted inventors could flee to a more open-minded area where they would be allowed to enrich themselves through their idea. European governments were not only unable to stop technological progress, they were generally unwilling. Many new ideas were simply too useful to monarchs with international rivalries and a thirst for gold. For example, better math and astronomy allowed for better navigation at sea, and opened up the possibility of obtaining the Eastern goods which Europe craved. So the possibility for thinkers and tinkerers to obtain refuge and protection remained [Mokyr, 1990, 223].

Mokyr himself points out that this “openness” resulting from Europe’s decentralized character should not be exaggerated. Certainly there are historical examples of government and the church sitting on ideas in Europe. This was especially true in times when the two

institutions were so closely wed, during the Reformation and Counter-Reformation. Giordano Bruno, an ex-monk whose vision of the universe was centuries ahead of its time, was burned alive in Rome in 1600. Galileo Galilei was placed under house arrest thirty years later for sticking to his own notions about planetary motion [Landes, 1998, 181-182]. Despite the frequently hostile intellectual climate which nonconformists faced, their ideas survived and were improved upon by later thinkers and inventors [Mokyr, 1990, 233].

China was different. There was little of the outright religious persecution and bigotry to be found in Europe, but there was a subtler discouragement of frontier-pushers. Generally speaking, China tended to be a “top-down” civilization in terms of initiative. So a disinterested bureaucracy and powerful trading guilds may have quashed useful ideas that threatened to redistribute income or power away from them. As a result, the productivity advantages of innovation was overlooked and lost. This blocking influence prevented or delayed the adoption of inventions in mining and transport, soybean-oil pressing and silk reeling [Mokyr, 1990, 233].

The very existence of the mandarin state may illustrate another factor in Chinese culture which indirectly stifled technological development: through diversion. Education and scholarship were desirable goals in the traditional Confucian ethical canon, and the bureaucracy had become an entrenched institution in China. Entering it was widely seen as a path to both material success and prestige; something for better-off families to strive for [Landes, 1998, 335-336].

The Chinese venerated their intellectual ancestors, and there were schools to teach Confucian literature and morals to those studying for the imperial examinations. This cultural bias toward education would seem beneficial in light of the desirable effects of education on an economy. Unfortunately, it proved to be a diversion of creative energies away from where they “should” have been. Bureaucratic activities are not the stuff of which an industrial revolution is built, and as a result there was very little organized (or even unorganized) scientific inquiry going on [Landes, 1998, 343].

It is true that pre-modern technological invention was not necessarily linked to the systematic process that we call “science.” It was mostly empirical in nature, a process of trial and error and of brilliant mistakes which could be turned to useful ends [Mokyr, 1990, 229-231]. So pre-modern technology usually progressed a bit at a time; through the

tinkering of craftsmen, the pondering of philosophers and the celestial observations of diviners, priests and early astronomers. The development of printing in both Europe (in the 1400's) and China (four-hundred years earlier) changed this and allowed new ideas to be transmitted much more easily than through hand-copying (Elvin, 1973, 179-181; Mokyr, 1990, 217-219).

So at some point networks of knowledge beyond the encyclopedias of Europe and China became extremely advantageous to further scientific inquiry and progress. In pre-industrial Britain, this took the form of the Royal Society which was chartered by James II in 1662 for the purpose of advancing English science. This organization not only counted the luminary Sir Isaac Newton among its founding members but held meetings and contests and published its findings. Europe also had its universities, whether they took the form of the navigation school founded by Prince Henry of Portugal, the halls of Oxford or France's Ecole Polytechnique. These sorts of institutions were able to bring together ideas and talents, and to transmit news about what was already known [Landes, 1998, 343-345]. This was vital.

China lacked this. As Landes puts it: "The history of Chinese advances, then, is one of points of light, separated in space and time, unlinked by replication and testing, obfuscated by metaphor and pseudo-profundity, limited in diffusion (nothing comparable to European printing)-in effect, a scattering of ephemera" [Landes, 1998, 343]. There were plenty of marvelous inventions in China, especially during Song times and there was plenty of writing on technical subjects, from farming to mathematics. Many of the inventions went unappreciated, unused and were quickly forgotten. In time, the books went unread and were lost to fire or just bad storage. Little was built on work which had come before. So in the end the institution of a merit-based mandarin class which seems so appealingly democratic on the surface probably hurt China [Landes, 1998, 343-345; Mokyr, 1990, 220-221].

Consider a single example: the magnificent water-clock built in 1086 AD by Su Sung for the Song court, centuries before the Europeans had anything like it. According to Mokyr it was probably the most advanced water-driven clock ever built, forty feet high and displaying various astronomical/astrological positions in addition to the time. Rather than exploit the useful applications of Su Sung's masterpiece or the water-clocks which had come before it, the courtiers seem to have regarded the device as a novelty. After all, time and the calendar in China

were the emperor's prerogatives to "give." By the 16th century, no one in China remembered that such a device had even existed [Mokyr, 1990, 214-15, 220].

The issue of clocks also provides a segue into a related issue: Chinese contact with Europeans. If technological progress had slowed in China by the late Ming dynasty, then why didn't the Chinese hungrily devour European knowledge when the Portuguese traders came calling in the 16th century? Ironically, the Jesuits who accompanied the traders gained audience with the bureaucrats and the court by bringing examples of mechanical European clocks to show them, but the Ming, like the Song, viewed these as toys, not tools (Landes, 1998, 336-337).

This seems to be another symptom of a Chinese worldview which had become complacent and convinced of its own glory. The Celestial Empire was, after all "...first in age and experience, untouchable in its cultural achievement and sense of moral, spiritual and intellectual superiority" [Landes, 1998, 335]. The new European devices were interesting and might well be useful, but China did not need them. And so the Ming Chinese ignored Europe's steadily increasing lead, with the exception of asking the Jesuits to teach their artisans to make clocks and cast cannon, which they installed in their fortresses and some of which were still around to be used in the 1840's against the British. They also adopted New World crops like the potato to feed their hungry population, but this was the extent of their borrowing, at least until much later [Landes, 1998, 335-340].

The inward-looking character of Ming China was nothing new, but it had not always been so. Between 1405 and 1430 the dynasty had sent the eunuch admiral Cheng Ho on a series of voyages as far west as the east coast of Africa. Cheng Ho's fleet included over three hundred vessels (some of which were more than 400 feet long) and 28,000 men. Then the court lost interest and China turned its back on exploration [Landes, 1998, 93-95].

After the mid 15th century the Ming even constricted all overseas trade until only a trickle of legal commerce entered China through treaty ports like Portuguese. China believed that it didn't really need trade after the construction of the grand canal linking the north and south, so why maintain a navy to protect it? Why even allow sea-trade at all? As a result, resources which could have been wiser spent elsewhere were shifted to fighting the smugglers and pirates who sprang up in the face of this self-imposed embargo (Elvin, 1973, 215-222).

So China forfeited the chance to launch its own age of exploration like that which Europe embarked upon half a century later. As morally repugnant as it is from our “modern” standpoint, European colonialism allowed for a diffusion of knowledge back to the continent and a growth of long-distance trading networks. This may have been an important step on the road to industrial revolution. It was colonialism which opened up lands suitable for sugarcane production and cotton. Colonialism also provided new crops like the potato which increased European food production on marginal land. Colonialism eventually opened up new markets for Experimentation and contact with other cultures may even have allowed Europeans to learn ways to conserve their soil resources and prevent further erosion at home [Landes, 1998, 68-71; Pomeranz, 2000, 9-10, 57-59].

Was it complacency which prevented the Chinese from doing the same? There was certainly no need in China to seek a route to the West. The Europeans had nothing to offer. So the voyages of Cheng Ho ended up as an expensive public relations tour; a way to show the flag and display Chinese superiority to the barbarians beyond the Celestial Empire [Landes, 1998, 94-95].

Even the philosophy of the period had become introspective. The dominant Chinese thought of the day is represented by the moral intuitionism school popularized by Wang Yang-ming in the 16th century. Scholars often cite this development as yet another stumbling block to effective scientific progress. Wang Yang-ming essentially taught that nothing existed outside the mind, and that discovering moral principles and truth was a process of looking within oneself. Compare this to the Neo-Confucianism popular during the Song era which stressed discovery of the underlying principles of the natural world [Elvin, 1973, 224-234]. Neo-Confucianism was a shift away from the traditional Chinese outlook to begin with. The Chinese spiritual outlook did not share the European belief in a personal god. The Chinese believed that manipulating the environment for human benefit was desirable, but not to the degree which European society encouraged. The general tendency in China was to see a balance between people and nature as desirable; there may have been a less aggressive drive to harness the discoveries which were made and to push for innovation which would make them practical [Mokyr, 1990, 227-229].

Worldview aside, China came very close to starting an industrial revolution, based on the reports we have about the scale of economic

output during the key period. Were they lacking one or two key inventions to complete the “process?” Kenneth Pomeranz thinks that the Chinese failure to harness fossil fuels for energy may have been a contributing factor. Recall that north China was the empire’s “political, economic and demographic center of gravity” until the 12th century. The region was devastated by the coming of the Jurchen and the Mongols, civil wars and natural disasters between the years 1100 and 1400 which permanently shifted the country’s leadership to the south [Pomeranz, 2000, 62-63].

The warfare and depopulation wrecked the advanced iron industry and coal mines of the north. As a result, there was a technological regression in both activities resulting from the lost human and physical capital. This may have had even worse long-term effects for China, since the north also contains most of the country’s coal deposits [Pomeranz, 2000, 62-63].

Coal fell out of favor as a fuel source in iron production until the 18th century, when the government tried to promote mining again. This was unsuccessful, owing partly to the fact that the mining rights were given to poor farmers, but according to Pomeranz “it seems unlikely that even better capitalized mines would have achieved the major breakthroughs needed to transform China’s energy, transport and metals sectors...” This may also have hurt Chinese chances of adopting a device known to them which was vital to the industrial revolution in Britain: the steam-engine [Pomeranz, 2000, 58-64].

Chinese mines were dry, but in Britain mines were wet and needed to be pumped out. The first inefficient steam-engines proved to be a labor-saving tool in mining, since the mines they pumped provided the abundant fuel necessary to run them. Further experimentation led to innovation and the steam-engine’s eventual role as the central transportation technology of the industrial revolution. It is debatable whether use in mining was the definitive cause of the European adoption of the steam-engine, but centuries had been lost in China along a path which might have yielded a similar breakthrough [Pomeranz, 2000, 58-64].

In the meantime, the empire had fallen into a Malthusian trap, its resources strained by overpopulation. Why didn’t an industrial revolution occur as a “response” to this pressure? After all, the technological slowdown which has already been described did not necessarily prevent this from happening. The Chinese still had many of the right pieces in

place, in light of the European experience. They had spinning machines which were just a step in complexity behind the spinning jenny of the British textile industry [Mokyr, 1990, 209-218]. They had huge markets right at home in need of clothing and the other fruits which the industrial revolution bore in Britain. There was plenty of commercialization in the Yangze delta, though wage bills were steadily rising as food and fuel grew expensive [Elvin, 1973, 298-316].

So why weren't the sort of capital improvements which would have made the Chinese labor force more productive in the 17th and 18th centuries adopted? Mark Elvin proposed his theory of a "high-level equilibrium trap" in the 1970's to explain this puzzle. His idea was that the intensification of population versus output had led to virtually no capital surplus by the 18th and 19th centuries and that this made investment in such capital-intensive inventions too expensive [Elvin, 1973, 298-316].

Other scholars have criticized the theory as being counter-intuitive, since it seems logical that such intensification would lead someone to profit from the development of labor-saving device and since some of the population pressure was relieved by plagues which may have wiped out 35% of China's population in the 17th century [Mokyr, 1990, 225-226]. Then again, as metal and wood became so expensive, why build machines? Labor was still relatively cheaper.

The China which greeted the European imperialists of the 19th century seemed a very backward place to them indeed. It was an overcrowded country where people lived hand-to-mouth and famine and pestilence were always waiting in the wings. The Chinese made their livelihoods in much the same way as their ancestors had at the turn of the millennium, but in those days they had been the envy of the world. It was a bitter pill to swallow for the proud people of the Celestial Empire.

III. Conclusion

In the end, there was no one direct cause for China's failure to live up to its own promise. Rather, the events discussed here seem to have had a cumulative effect upon the course of Chinese economic history which pushed it off a course which might have led to an industrial revolution. It is important to remember that each of those major causes discussed above was affected in turn by hundreds of other factors.

However, a large share of what happened is attributable to significant differences in the character of the European and Chinese

civilizations. The larger social institutions in China, particularly those under the Ming and Qing dynasties, caused significant distortions in incentives and inventiveness which were compounded by other problems that prevented China from industrializing. Laying the blame on these institutions clashes with that of many China scholars.

To them, it is Europe's success which is the anomaly in need of explanation, not China's failure, if it is in fact a failure [Landes, 1998, 346-349]. Perhaps this is true, but China's awe-inspiring record of technical achievements during the middle ages and its subsequent slowdown begs an explanation. So far, many of the best answers seem to point toward its centralized nature, which allowed a shift in attitudes among the imperial elite to turn the entire nation toward isolationism. Once on that path, China chose to ignore European gains, favoring complacency instead.

New comparisons of the specific pre-industrial factors in both China and the west, such as Kenneth Pomeranz's *The Great Divergence*, still deserve further attention and may yield new perspectives on this very difficult and important problem. It is difficult because of the problems inherent in working from any historical record, which is always a patchwork of surviving documentation and the findings of archeologists. It is important because finding the answers will tell us much about the accuracy of the economics profession's models of the role of technology in macro-economic growth. Understanding this problem also allows us to understand the motives of a China which is rapidly reasserting itself on the global stage. In short, this is a subject which may prove vital to our understanding of how to raise the standards of living for the poor nations of the world and vital to diffusing tensions between China and the West.

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