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Sung Dynasty Technology
A precursor to the Industrial Revolution

The Sung dynasty (960-1279 CE) was known for its many astounding advancements in the areas of technology and economics and can be viewed as a precursor to the European industrial revolution. Unfortunately the industrial revolution did not start in Sung China and we aren't speaking Cantonese right now. Many theories have been put forth as to why the industrial revolution didn't begin in 12th century China, including cultural and economic restrictions and the high-level equilibrium trap[1]. The problem is many people try to narrow the reason down to just one of these explanations when it is in fact a combination of all of these and more. This paper will present a broader reason as to why the industrial revolution that took place in Sung China never took hold, and that is because the Chinese restricted it themselves.

Starting in the 10th century, the Sung dynasty experienced a burst of technological, agricultural, and economic advances that led it to become the economic powerhouse of the world. Examples of their innovations are many, the first of which was the foundation for these advances, the development of fast growing rice. In the first half of the Sung dynasty Northern China was under threat from the Northern Mongolian groups the Jurchens and the Khitans. Fearing a take over, Huizong's (1100-1125 CE)[2] leading general Tong Guan made an alliance with the Jurchens in order to defeat the Khitans and divide their land. While they defeated the Khitans, there were unexpected consequences that took a heavy toll on the Sung. As Ebrey describes it:

> In the process of defeating [the Khitans], [the Jurchens] discovered that the Sung was not much of a military threat, and attacked it next. Kaifeng was besieged, an enormous ransom paid to escape slaughter… …[The Jurchens] went on to

[1] Mark Elvin's theory which will be explained later in the paper
[2] The emperor at the beginning of the Sung

> establish a stable government in north China and Manchuria… …[The Jurchens] continued the dual government of [the Khitans] and employed former [Khitan] officials.[3]

One of Huizong's sons was later installed as emperor and he moved the Sung capital to Hangzhou, a city deep in the south of China, in order to get as far away as possible from the Jurchens. It was this move that allowed the Sung to experience great advances in technology and agriculture, as it led to the effective use of fast growing rice, which was discovered on a campaign into Vietnam led by the Tang dynasty. By utilizing this rice, farmers could harvest two or even three crops a year, as opposed to just one. As Anthony Tang describes it: "the Chinese peasant practiced land-intensive crop rotation and multiple cropping centuries before England popularity replaced the wasteful 'open-three-field' system by the Norfolk crop rotation which paved the way for the celebrated agricultural revolution."[4] This led to a great increase in population during the Sung dynasty, as John Durand indicates:

> Population estimates calculated by multiplying the numbers of households by the assumed average of six persons indicate that the population was about 55 millions at the beginning of the eleventh century and increased to about 120 millions during the next 100 years. This great increase… …has been interpreted as the result of… …outstanding achievements in the economic sphere, including an extensive development of irrigation works and expansion of settlement in the south.[5]

It was this population explosion that allowed for the further breakthroughs in technology and agriculture. The great size of China's population at this time provided for a multitude of experience-based inventions[6] and innovations developed by peasants through trial and error. These inventions --gunpowder, the magnetic compass, paper and printing-- are what many scholars believed were the most important inventions that facilitated the

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[3] Patricia Ebrey, *Pre-Modern East Asia: to 1800 A Cultural, Social, and Political History* (New York: Houghton Mifflin Company, 2006), 165-167
[4] Anthony M. Tang, 'China's Agricultural Legacy', *Economic Development and Cultural Change* (1979) 3
[5] John D. Durand, 'The Population Statistics of China, A.D. 2-1953', *Population Studies* (1960) 226-227
[6] Innovation that stems naturally from daily tasks; learning and improving from experience

West's transformation from the Dark Ages to the modern world.[7] The reason China experienced such technological innovation so early on is explained by the theory that in premodern times, technical innovation stemmed from experience. The great size of China's population at this time provided for a multitude of experience-based inventions and innovations by cause of the trial and error of peasants.

Now that the reasons for the mini industrial revolution experienced in China have been outlined, it is necessary to examine, but not dismiss, the theories of why an actual industrial revolution did not occur. The first and most widely regarded reason for a failure to launch the industrial revolution comes from Mark Elvin and is what he calls the 'High-Level Equilibrium Trap.' To sum up his theory:

> In its simplest form, Elvin describes the trap in these terms: technology had developed to the fullest extent possible (in agriculture and water transport, for example) without a discontinuous jump involving application of modern scientific inputs… …thus Elvin's account has at its core a view about the prerequisites for technical innovation; he explains the failure of economic revolution in China as the consequence of the absence of the necessary preconditions of technical innovations.[8]

It is further explained that the trap consists of five main parts: population pressure on resources, an over-supply of cheap labor (favoring labor-intensive innovations), market efficiency and size, the organization of the unit of production, and a lack of available innovations that are both economically and technically feasible. Although this explanation sounds like a well thought out and accurate reason for the Sung's failure to initiate an industrial revolution, it should not be looked at as the sole reason. This trap can be disproved by arguments proposed by Justin Yifu Lin. Elvin's main cause for the failure is the lack of demand for labor saving devices, due to the increasing population and subsequent increase in available, cheap labor. Lin quickly rebuts this:

> The central assumption implicit in this [theory] is that of a bounded potential of agriculture in premodern ages. However, given the land, labor, and social

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[7] Justin Yifu Lin, 'The Needham Puzzle: Why the Industrial Revolution Did Not Originate in China', *Economic Development and Cultural Change* (1995) 270

[8] Unknown author, 'The High-Level Equilibrium Trap', http://www-personal.umd.umich.edu/~delittle/elvin.pdf, 1-2

> institutions, the potential of agriculture, whether in modern or premodern ages, is a function of technology. If the development of technology is not inhibited, an 'equilibrium trap' due to the adverse man-to-land ration is not present.[9]

Lin goes on to further argue against Elvin's theory using population, per capita acreage, and income figures. The details of this argument though are not important. What is important is that the exact reasons for the failure to initiate an industrial revolution cannot be narrowed down to one single theory, but rather to a combination of the reasons these theories present. These theories, as this paper will argue below, coincide with each other along with later cultural and political standards and practices that prevented an early Chinese industrial revolution.

The main reason that the industrial revolution did not start in China is because of several of the Ming dynasty policies. The Ming dynasty took control of China after 1279, and in doing so, ushered in many new policies. The first change that deterred the industrial revolution from starting was the promotion of their views on foreign policy. The emperor that made these changes, Ming T'ai-tsu, enforced the idea that the Chinese were better than other nations and merged existing tributary systems[10] with trade. John Langlois explains:

> Ming T'ai-tsu's eventual merger of tributary relations with foreign trade was far from 'orthodox.' Instead, it was unprecedented. And indeed, T'ai-tsu put severe limitations on foreign trade that remained more or less in force until the end of the dynasty. [11]

The impact of these trade restrictions was to prevent and hinder the spread of the innovations created by the Chinese. Coupled with the belief that Chinese had that China was better than foreign states, one can assume the Ming court wouldn't want to share their boom in technology with other nations. In addition, during this time the Chinese were able to defeat the Mongols and establish other new policies that can further explain the failure of the Chinese industrial revolution.

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[9] Justin Yifu Lin, 'The Needham Puzzle: Why the Industrial Revolution Did Not Originate in China', *Economic Development and Cultural Change* (1995) 272

[10] The reception of foreign envoys

[11] Review author: John D. Langlois, 'Early Ming China: A Political History', *Journal of the American Oriental Society* (1985) 767

> The victorious expulsion of the Mongols permitted a reduction in military expenditures; this in turn permitted the heightened emphasis on agriculture. Agriculture was favored by the emperor, reflecting in that his agrarian background and the influence on traditional Confucian political thought. In addition, the emperors own strong desire to maintain firm control over the reign tended to favor agrarian policies, since commercial growth would have created independent power centers outside the regimes control. [12]

This along with another distraction in the form of a Ming institution also prevented the industrial revolution. As explained by Lin:

> A larger population means more geniuses, and therefore, in premodern times, implied probabilistically more achievements in premodern science. However… …without the necessary acquired human capital, the society will not be able to launch a scientific revolution. This special human capital, a necessary requirement for membership in the club of modern science, is expensive and time-consuming to acquire. [13]

To further paraphrase Lin's theory, there were several reasons that were imbedded in Chinas historical and political legacy as to why the gifted in ancient China had fewer incentives than their Western counterparts to acquire the human capital required for 'modern' scientific research. After the Qin unification in China in 221 BCE, bureaucrats ruled the state. Civil service examinations were instituted during the Sui dynasty, and after the Sung dynasty, all of the ruling bureaucrats were selected through these competitive civil service examinations. Government service was at this time in premodern China the most honorable and in every sense of the word the most worthwhile occupation to hold.[14] Since these examinations were so alluring and so time consuming, taking upwards of 6 years of memorization, the geniuses in society would have little to no incentive to conduct scientific research. Furthermore, after these examinations, the elite would be too bogged down with their official duties and would be more interested in climbing in the ranks to worry about scientific research. This examination system led to

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[12] Review author: John D. Langlois, 'Early Ming China: A Political History', *Journal of the American Oriental Society* (1985) 767

[13] Justin Yifu Lin, 'The Needham Puzzle: Why the Industrial Revolution Did Not Originate in China', *Economic Development and Cultural Change* (1995) 284

[14] Lin 284-285

distractions and prevented the people who could have caused an industrial revolution from doing so. Society in China couldn't make the transition from innovation from trial and error, to innovation on purpose, or experiment cum science, which is what would have been required to start an industrial revolution.

When it comes to an industrial revolution rooted in China, the means and ability were there, but various restrictions prevented those means to flower. The reason for failure is not simply a case of bounded agricultural innovation and lack of demand for technical innovation, but is a response to the limitation placed on the would-be inventors by the society at the time. The emphasis placed on agriculture and the time-consuming civil service examinations prevented the necessary innovations required to start an industrial revolution. Plus, even if said innovations were allowed to occur, the heavy restrictions on foreign trade would have greatly hindered their spread, and the world would not be united enough to experience a universal industrial revolution. In conclusion, it was ironically the Chinese own fault for their failure to start the industrial revolution.

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