**The Needham Puzzle**

*August is a quiet month in the international political domain. So, I decided to write about a historical subject. The Needham Puzzle is about the question why China had been so far advanced of other civilisations before the sixteenth century and why, during Needham’s lifetime, China was not any longer ahead of the rest of the world.*

Joseph Needham (1900-1995) taught biochemistry at Cambridge University. Living in England, that had brought about the Industrial Revolution, Needham thought that all advanced technologies had been developed in England or in other European countries. It so happened that he had a female student, Lu Gwei-djen, in his lab whose father was a professor of history of science at Peking University. Lu had learned a lot from her father. When Needham once told his students that a certain technology was invented in Europe, she corrected him by telling that the invention had taken place in China; she could even tell Needham in which book he could find it.

This information triggered his curiosity. He started to study the history of Chinese science and technology. During World War II, Needham was posted as British cultural counsellor in Chongqing. During his travels in China, Li Yuese (Needham’s Chinese name) collected a lot of historical materials, which now belong to Cambridge University’s Needham Library.

Needham studied in which year a certain technology, tool or machine was invented. He discovered that before the 15th and 16th centuries technology flowed one way: from East to West. After all, China had invented cast iron, the plough, the stirrup, gunpowder, printing, and the magnetic compass, among others. But in the 16th and 17th centuries, some technologies started to flow from West to East. After the middle of the 18th century, the flow was exclusively from West to East. This insight constituted the basis for the *Needham Puzzle*: Why had China been so technologically advanced compared to other countries, and why was China not any longer ahead of the rest of the world?

Justin Yifu Lin deals with the question in *Demystifying the Chinese Economy* (2012). He proposes a theory to unravel the Needham puzzle. Lin goes back to the Industrial Revolution. The defining phenomenon of it was the *acceleration* of technological innovation. This is why the gap between China and the West became ever wider. On top of it, England developed many more new industries such as the chemical, automobile, aerospace, and information technology industries.

Lin introduces the technology distribution curve (shaped like a Bell curve), divided in low technology at the left half, and high technology at the right half of the curve. Factors like talent, newly developed material (such as steel) and knowledge move the technology distribution curve to the right, meaning that the more a country avails of these three factors, the greater the chance that new technological inventions will ensue. Lin proposes three hypotheses: (i) the more trials and errors that are carried out, the greater the probability of inventing a new technology, (ii) the more advanced the current technology, the lower the probability of inventing a new technology, and (iii) after the discovery of one technology (e.g., steel) more tools were invented one after the other. Based on these hypotheses, Lin answers three questions:

1. Why was China so advanced in premodern times? At the time, invention was based on experience. China had a large population, and the larger the population the larger the number of craftsmen and peasants, and- therefore - the greater the chance for inventions. Hence, abundant human resources laid the basis for technological progress in those early days.
2. Why did China lag behind Europe in modern times? In Europe after the 18th century, invention was based on *experiment* and no longer on experience. Trials and errors were now mainly based on intentional experiments. A scientist in a lab can do more trials than thousands of craftsmen and peasants. So population was no longer an issue. To counter the diminishing experiment results effect, European countries increased basic research, triggering more technological innovation. The precondition for basic research was the Scientific Revolution that took place in the West, even before the Industrial Revolution. The Scientific Revolution contributed to the Industrial Revolution in two ways: it introduced a revolution in methodology (i.e., controlled experiment replaced experience as the basis for trial and error) and it facilitated the shift to the right of the technology distribution curve.
3. Why did a Scientific Revolution did not also take place in China? Modern science uses mathematical models to formalise its hypotheses, and uses controlled or reproducible experiments to test them. Mathematical language is much better than natural languages in disseminating new knowledge. China had a bureaucratic system whereas Europe had a feudal system, more favourable to mercantilist values. With the collapse of the feudal system, capitalism and modern science could fully emerge. In China, merchants had a low position in the Confucian system; they were barred from the civil service examination system. China also did not promote the development of good mathematicians nor did it warm to scientific experiments. True, when the civil service examinations were introduced by the Qin Dynasty, mathematics was one of the subjects. However, towards the end of the 16th century, Emperor Shenzong decided that mathematics was of little use and scrapped the subject. Without people mastering mathematical tools, the Scientific Revolution could not take place in China.

China’s initial prosperity had a lot to do with its civil service system. And when the basis for technological innovation shifted from experience to experiment , like it did in Europe, the system lost its superiority; worse, it even hindered scientific and technological progress.

The key issue, concludes Lin, is the absence of the Scientific Revolution in China, without which the Industrial Revolution could not have happened. And without the Industrial Revolution, technology could not accelerate. That is why capitalism, though sprouting in China, failed to develop there fully since the 18th century until recently.

**Peter de Haan July 2019**