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Project Report

History of Technology Adoption and Development: The case of Silk Industry in Colonial India*

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1. Introduction

The current project seeks to understand the process and impediments of technological adoption through the lens of history. Specifically, this project will look at the issue of European technology adoption in silk weaving industry. Such understanding has huge implication for technological policies in present time. Usually technology is thought to be an objectively detailed, asocial blue print whose success does not depend on social organizations. But various studies show that development of technology critically depends on social structures and values. In this project we analyze different possible socio economic reasons behind the failure of the adoption of filature technology in silk industry in Bengal in eighteenth century. The project was accomplished under the following chapters:

I. Introduction
II. Indian silk and international market
III. Production structure and technology adoption
IV. Colonialism and technological adoption
V. Conclusion

2. Research Question

In the second part of the eighteenth century the East India Company (EIC) aimed to capture the European market for silk by importing it from Bengal. The major obstacle for out competing the Italians — the then leader in the world silk market – was the uneven quality of Bengal silk. The East India Company tried to solve the problem by adopting the mechanized silk reeling method known as the filature system. In 1769, the court of directors had sent a team of Italian mechanics comprising J Ruggiero, Dominicus Poggio, C F Bricola and Augus Della Casa to Rungpore for setting up filature and training Indian artisans. The Company, with the help of these mechanics, built a few filatures across the silk producing centres of South Bengal. This endeavor however, could never yield the desired result for the Company as the Indian artisans by and large showed reluctance to use this technology. This dealt a blow to the Company's dream to take over the world silk market. Initially there was some increase in silk export from India but that was never sufficient to replace the Italians.

Although the court of directors introduced the modern filature machine in India in 1769, it took about fifty years for the Company to convert the whole of its investment in silk into filature assortment (Mukhopadhyaya, 1996). Despite the technological superiority of the Italian technology, the artisans from Bengal by and large rejected it. Also, the upgrading process desired by the Company met with only partial success, for Bengali raw silk reeled with the new method never reached the highest standards of the Piedmontese raw silks (Davini, 2009). Thus there was a chasm between this blueprint of filature technology and the actual adoption of it in eighteenth century India.

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3. Existing literature

The British observers such as the Governor General and his council and the Bengal Board of Trade held the culture of the artisans responsible for this. They held the view that the artisans' lack of openness towards new technology was mainly responsible for this rejection. According to them the Indian artisans were not enterprising enough, their dominant instinct being that of self preservation rather than business proliferation. E Close, from Rangamatty reiterates this colonial view:

> "When you have the common plant of the country and the common earth to deal with the natives themselves are by far the best judges what to do with them and whenever they do fall short of the success of an European, you may rely it is not the want of art but absolute indigence."

Modern historians writing in twentieth century however, discredited the view held by EIC and offered hosts of socio economic explanations. We can broadly classify the explanations in two groups. While one group of historians located the cause in the production relation between weavers and the Company, the other group nailed the cause in the production relation between the cocoon rearers (chassars) and the Company. Writings of historians like Bhattacharya (1966), Mukhia (1985) and Bhadra (1991) belong to the first group while the second view can be traced in Mukhopadhyaya (1996) and Davini (2009).

Let us have a brief discussion of the views held by different historians. From the first group, Bhattacharya (1966) entailed that introduction of filature technology, because of the high fixed cost of the technology, transformed the structure of production from artisan based production to a capitalist production system. This resulted in resistance from the artisans and people involved in other stages of production. Such resistance was instrumental in creating the ground for failure.

Mukhia (1985) on the other hand, argued that the price difference between *Putney* (indigenous silk) and filature silk was not enough to compensate for the higher work fatigue involved in the process of filature reeling compared to indigenous silk production technology. Finally, Bhadra (1991) pointed out that the main market for filature silk could only be found in Europe. Higher risk involved in maritime silk trade dissuaded the artisans to specialize in filature silk.

Davini (2009) and Mukhopadhyay (1990) on the other hand belong to the second group who mainly blamed Company's policy to acquire Cocoon by coercion and not giving proper price to the *chassars*. However, their explanation failed to answer why the silk yearns produced in the factories failed to reach the desired standard. We therefore concentrate on the first group of explanations and reexamine their hypothesis with new data from international scenario.

4. Contribution of the Study

In this backdrop contribution of my study is threefold. First, I put the question of filature technology adoption in the international perspective by comparing the Indian case with the case in Japan where the same technology was successfully adopted. Second, in light of the Japanese experience I put forward a new hypothesis and third, I test the existing hypotheses as well as the new hypothesis using data from Bengal and Japan.

5. The International Experience

The filature technology moved to China and Japan in the nineteenth century after meeting with rejection in India. The performance of Japanese raw silk exports was in sharp contrast to that of China. In 1873 China exported thrice as much raw silk as Japan but by 1905 Japanese exports had started exceeding those of the Chinese and in 1930 Japan was recorded to gain an enormous 80% share in the global market. In the early nineteenth century, the world silk trade was dominated by Italy with India and China being distant second and third. However, things started to change from mid nineteenth century – 1859-61 when Japan started competing for the share of world silk market and within fifty years they became the dominant player in the market with 41.5% share. It is also notable that Italy ended up in the third position and India almost disappeared from the market.

6. New Hypothesis – Role of Micro Innovation

Our hypothesis is formed from the Japanese experience. The success of the Japan in adopting the new technology, we argue, lied in their ability to encourage micro-innovation. The eventual success of Japan did not look very smooth in the early days of the introduction of the new technology which faced some early resistance. Despite these early stumbles, there was a sharp rise in the number of steam filatures established from the end of 1870s. But more than this quantitative change, what we find particularly impressive about the micro-innovation done by the Japanese artisans. This experience is consistent with the general literature on technology adoption which suggests that micro-innovations play an important role in technology adoption. We find that the Japanese silk weavers introduced some very important changes in the standard European blueprint of filature. In the first phase of technology adoption around 1870, Tomioka filature did the reeling in two stages which was done in one stage in Europe. But innovations were not restricted to big factories — smaller companies contributed significantly in the process of micro-innovation and the resulting adoption. Sometimes small companies were forced to come up innovations because of their capital constraint. Small enterprises such as Rokkusha filature which started its operation in 1874 took the Tomioka filature model but simplified the equipments considerably to cut on the set up cost. The most important innovation which came out during this period was done by Nakayamasha company in the early twentieth century. This was a company set up by nine small silk artisans led by Takei Dajiro. They blended both the French and Italian technology to come up with a proto type known as Suwa method .The Suwa method was characterized by some important points of departure from the Western blue print. Such differences could be spotted in different aspects of the production process —material used for the factory building, power source, shape of reeling basin, twisting devices etc (Nakamura and Molteni, 1994, pp. 33-34).

7. Incentives and Innovations in Bengal Silk Industry

The Japanese case showed that European technology could only be used after some factory level adjustments were done to the original blue print and such adjustments were done by the Japanese artisans. I argue that unlike the Japanese case the EIC did not have any mechanism that could effectively encourage micro-innovation. The first best solution could be micro innovation by the weavers. But rather than encouraging the weavers to tinker around the blue print, EIC made sure that the weavers never deviate from the blue print. The only experiments we could find were done by the British officers. For British employees (especially resident officers) the only incentive mechanism available was to allow them to participate in private trade in silk trade over which EIC had monopoly. In presence of private trade, the officers could get profit from selling filature silk in Europe. Therefore, with the right to do private trade they had direct incentive to improve upon the quality of filature silk. I showed that the policy of allowing private trade was inconsistent and failed to create any sustained effect on the innovation. I showed using the data on silk price that whenever price of filature silk started to drop, EIC opened the trade but withdrew the privilege again when price of silk started to rise. Therefore, the policy instrument of private trade in silk did not have any credibility. Theoretically also such policy was time inconsistent. The British officers could see that once the improvement was done the private trading right could be revoked and that would provide disincentive to improve the quality of silk.

Nevertheless, British supervisors and overseers undertook some innovation which I detail using archival data. Mr. Wiss, stationed in Commercolly made use of the brass cog wheels to spin a superior quality thread. Mr. Weiss had given some instructions for winding Bengal wound silk following the Italian method. Resident at the factories were asked to pay particular attention that a large quantity of water be saved in their reservoirs as clean water helps in winding the cocoons and also gives a shine to the colour of silk. They were instructed to keep dry wood at hand to be used to at the filature as using green wood would lead to loss of time as the spinner would not be able to maintain the temperature of the water needed for the winding of the cocoons. It was argued that a furnace which would use green wood would use a greater quantity of the wood and produce less quantity of silk and that too of a bad quality than dry wood which would produce larger quantity of better quality silk. The pan used for the winding of the silk was required to be full of water all the time and the spinner had the discretion to reduce or increase the fire of the pan according to circumstances but it was absolutely essential for the pan to be ignited with dry rather than green wood. Cocoons were not permitted to be allowed into the factories until and unless it was deprived of the fuzzy silk as that would cause great convenience to the *chassars* and also to the Company. This was primarily because then the cocoons would be less likely to become mouldy and in turn the silk will be cleaner. Damaged cocoons were required to be handled carefully and removed from the good ones as soon as they arrived into the factories as cocoons that were bruised or where the worms were squashed would damage all the other good cocoons they came in contact with. Such cocoons would become mouldy, dirty the water in the pan and also destroy the colour of the silk. Water dirtied by the bad cocoons would tend to become thick and would be incapable of diluting the gum of the good cocoons. Damaged cocoons, that in which the worms died before they could be killed by the heat of the oven, generated coarse silk and they were instructed to be kept for the Indian market. But for good cocoons which might have turned bad for being kept too long as it was not always possible to bring all the cocoons into silk, it was instructed that care should be taken that the cocooneries in which the cocoons were kept be roomy and well aired. The Resident was instructed to be present and look into the placing of them properly into the shelves. He should make sure that no depth than four or five inches of cocoons be placed on one shelf and that they be turned once or twice everyday during the day. This sort of care will ensure that the cocoons would not grow mouldy and produce fine silk all around the season. The practice of killing the worm in the cocoon with the help of the hot oven was so very acknowledged that the Residents refused to buy cocoons in which the worm had been killed by the heat of the sun. The heat of the sun was believed to weaken the silk and also destroy its colour. On the other hand cocoons which were put into ovens were supposed to produce silk of a greater degree of consistency.

It should be noted that Commercolly remained the best factory for the Company. However, Company's board in general had the view that conforming to the blue print imported from Italy could produce the best result. In a letter by Court of Directors to the Governor General written in 1780 it was written that,

> "The reel on which the silk is wound must not form a skein longer nor shorter than 40 inches which is the same as 80 inches in circumference, in order to which, the outer edge of the four staves of the reel must be 20 inches distant from each other. The smallest size skeins that come from Italy are 36 inches in length which is the same as 72 inches in circumference and 18 inches distant from one stave to the other, which is the smallest size that can be wound off on the mills, but the size we direct is preferable on account of greater dispatch at the filature, and of drying faster."

The Company's adherence to the blue print is further revealed by a letter by Mr. Wiss (Letters to Court of Directors 1780)

> "The Board of Trade gave their servants permission to use cog wheels made either of brass, iron or wood, provided they should not be upon a different principle from the Piedmontize ones already in use"

The last part of these instructions clearly reveals EIC's preference to stick to the foreign blue print. I could locate at least one filature in Howrah where experimental filature was used. We find some limited evidence from comparison between experimental filature in Howrah with that the filature at Cottorah under Harripaul factory. In the Howrah filature the innovations used were 1) Mr. Becher's quadruple copper basins, set in masonry with water pipes, cocks etc, 2) Captain Somerville's furnaces with four copper basins and iron doors and 3) Mr. Shakespear's pottery ghyes of four basins, with Chimneys. Comparison of Cottorah filature with the Howrah factory which had conventional filature shows that there was some cost saving at the Cottorah filature. The amount of gain however varied with time of harvest. For March (large) harvest the savings was Rs.1 Anna 1 and Paise 1 while for March (small) and April and Rainy seasons the gain was Rs.1 and Anna 1. For October and November, the gain was much larger at Rs.2, Anna 5 and Paise 5. However, such experiments could not deliver sustained impact and eventually failed. I argue that more experiments could have delivered sustained improvements.

8. Reexamining Existing Hypothesis

In this study I also test some of the existing hypotheses using international data. I test Bhadra (1991)'s hypothesis which claims that filature silk failed because higher risk involved in the trading of filature silk which could only be sold in Europe. I calculated coefficient of variation in the price and quantity of silk and compared that with that of other commodities including indigenous silk (Putney) and filature silk in Japan from the period when filature was adopted. I find that Indian filature silk market was not exceptionally volatile. In fact, it was less volatile than Putney silk market in eighteenth century India and filature silk market in nineteenth century Japan. Hence, market risk was not a good reason behind filature adoption in colonial India. I also analyzed the internal organization of filature factories and compared that with indigenous silk factories. I could not get data on indigenous silk produced by artisan in a family set up. All I could get is data on Putney silk produced in factory set up. However, I did not find any significant difference between these two types of silk production in terms of the wage structure.

9. Conclusion

In this project, using a historical case study, I tried to answer a fundamental question of development economics — why do societies fail to adopt a more productive technology. To be more specific, I examined the question of filature technology. Filature is the machine reeling technology for weaving silk. The East India Company tried to introduce this technology from Italy to solve the problem of unevenness in Bengal silk. Bengal artisans however rejected the new technology and the filature project taken by the Company was largely unsuccessful and finally by mid nineteenth century, the Company sold their factories to private agents.

Colonial rulers largely blamed the artisans for this failure. However, this view was largely discredited by the modern historians. Contemporary historians identified two broad areas to locate the answer to this puzzle. One set of historians found the production relation at the factory and silk market responsible for the failure while some others found the answer lying in the production relation between the cocoon growers (*chassars*) and the Company. However, the answer based on the production relation between the cocoon growers and the Company does not satisfactorily answer why the produced thread using filature failed to attain the required quality. In this project I reviewed both the strand of the literature but tested the first set of hypothesis with international data.

Besides reviewing the existing literature I also proposed a new hypothesis where by making a comparison with the Japanese case where adoption of filature was successful, I conjectured that in India adoption failed because of the lack of micro innovation. I then theoretically analyzed why East India Company's dual role as the ruler and as the monopoly merchant prevented them from creating any incentive for micro-innovation. I provide support for my hypothesis using archival data.

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