# The British Silk Connection: The English East India Company's Silk Enterprise in Bengal, 1757-1812

Karolina Hutková

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# Declaration

This thesis is my own work and has not been submitted for a degree at another university.

## Abstract

Bengal raw silk was never renowned for its high quality, yet it attracted the interest of the European trading companies from the seventeenth century. This thesis explores the English East India Company's silk manufacturing activities in Bengal and the Company's trade in Bengal raw silk in the late-eighteenth and early-nineteenth centuries. The Company's interest in Bengal raw silk was driven both by economic and political factors – profit maximization and mercantilist ideas about governance. The English East India Company considered Bengal raw silk to be an item with potential high returns as the British silk weaving industry required supplies of raw material unavailable domestically. However, the quality of the Bengal raw silk was low and it could not be easily used in British weaving. Britain thus relied on the importation of raw silk from Italy, Turkey and the Mediterranean region. The English East India Company saw an opportunity to replace these supplies with silk imported from Bengal. In order to improve the quality of the raw silk produced in Bengal, the Company decided to adopt the Piedmontese system of silk reeling – the most advanced reeling system in Europe. The thesis shows that this new system of reeling was profitable. Yet, the quality of the Bengal raw silk did not improve as much as expected: a large part of the silk produced was of substandard quality. My thesis argues that the primary reason why substandard raw silk was produced was the inadequate institutional framework of production which facilitated principal-agent problems.

# List of Abbreviations

| | |
|---|---|
| BL | British Library, London |
| EEIC | English East India Company |
| G. L. | Goldsmiths Library, London |
| IOR | India Office Record, BL, London |
| LSE | London School of Economics and Political Science |
| RSA | Royal Society of Arts, London |
| TNA | The National Archives, Kew, London |

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## Measures and Currencies

Most of the price figures in this thesis were converted from Sicca Rupees into £, shillings and pences. The conversion used was: 1 Sicca Rupee equals to 2s. 2 d. The conversion used for liras was: £1 equals to 25 liras. One lira equals 20 soldi and one soldi equals 12 denari. Measures of weight in this thesis are either in sm. lbs. of 16 oz or gr. lbs. of 24 oz. The figures were converted from weights used in Bengal: Bengal factory Maunds and Seers. One Bengal factory Maund equals 40 Seers and that equals 75 sm. lbs. Seers consisted of smaller units called Chattaks: 16 Chattaks equals one Seer.

# INTRODUCTION

Despite the longstanding interest in both the English East India Company (EEIC) and the silk industry, few studies have explored the Company's silk manufacturing activities in Bengal. My research considers the connection between the British and Bengal silk industries. The latter was reshaped by the EEIC in the attempt to substitute the importation of raw silk from Italy, Turkey and Mediterranean Europe into Britain with Bengal raw silk and to widen the Company's silk trade. My research focuses on the transfer of Piedmontese silk technologies to Bengal – the key part of the Company's silk manufacturing activities. I will first introduce my PhD research and explain the main argument of my thesis. I will then consider the literature, and sources and methodology used. Finally, I will explain the structure of my thesis.

Silk has long been considered the queen of fabrics and has been associated with luxury consumption. Silk never achieved a high share of the global fibre market and yet, the economic, social and cultural role of silk in pre-modern societies far outweighed its quantitative importance. As a labour intensive industry, silk manufacturing produced goods of high value and brought revenues through taxation. Domestic production of silk prevented the outflow of bullion – something abhorred by mercantilists.[1] Due to its high-value and low volume, silk became one of the first

[1] Debin Ma, 'The Great Silk Exchange: How the World Was Connected and Developed', in Debin Ma (ed.), *Textiles in the Pacific, 1500-1900. The Pacific World: Lands, Peoples and History of the Pacific, 1500-1900* (Aldershot: Variorum, 2005), pp. 4 and 25; Mary Schoeser, *Silk* (New Haven: Yale University Press, 2007), pp. 13-14. It is difficult to estimate the number of workers employed in the sector in the early modern period, especially as the tasks of sericulture and reeling were not the only ones that household members undertook. Although silk throwing, weaving and dyeing were centralized trades, it is equally difficult to estimate the number of workers employed in each of them. For discussion of these issues see Giovanni Federico, *An Economic History of Silk Industry, 1830-1930* (Cambridge: Cambridge University Press, 1997), pp. 14-15.

globally traded commodities. Thanks to its potential for employing the poor, the silk industry was also considered a strategic industry in the early modern period.[2]

Scholarship has asserted the role of the silk industry in fostering economic development in the early modern and modern periods.[3] The contribution of the silk industry to development, was however, reliant on the adoption of up-to-date technologies. As in many cases of technology transfers, the process of adoption of silk cultivation and production was plagued by a series of problems threatening its success. Several of these issues were connected to technology transfers in general, while some were specific to the silk industry. This study focuses on the transfer of silk reeling technologies from Italy to Bengal in the late eighteenth and early nineteenth centuries. It considers in particular the issues that influenced or threatened the success of the adoption of this European technology in Asia: an inadequate institutional framework for the production of silk, incompatible factor endowments, lack of adaptation, etc. My study considers several key themes featuring in both development studies and economic history, in particular factor prices, institutions, principal-agent problems and

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[2] See, for instance, Luca Molà, *Silk Industry in Renaissance Venice* (Baltimore: Johns Hopkins University Press, 2000), pp. 34-36.

[3] The role of silk industry in economic development was in particular stressed by Debin Ma in a study explaining the differing paths of industrialization and development of Japan and China in the early nineteenth century. Debin Ma, 'Why Japan, Not China, Was the First to Develop in East Asia: Lessons from Sericulture, 1850-1937', *Economic Development and Cultural Change* 52 (2), 2004, pp. 369-94. In the nineteenth century, the silk industry contributed to the development of other East Asian countries as has been noted by Kazuko Furuta. Kazuko Furuta, 'Silk Reeling in Modern East Asia: Internationalization and Ramifications of Local Adaptation in the Late 19th Century', in Ma (ed.) *Textiles in the Pacific*, pp. 191 and 195-206. Sanjay Sinha draws attention to the development potential of the silk industry in labour-abundant and agro-based economies. Sinha argues that the silk industry should have been promoted in rural parts of India even in the twentieth century because of its employment potential – especially for women – and because it encourages technological upgrading. Currently both the United Nations and the World Bank are promoting the silk industry as a sector with high potential for poverty alleviation. Sanjay Sinha. 'Development Impact of Silk Production: A Wealth of Opportunities', *Economic and Political Weekly* 24 (3), 1989, pp. 157-63.

management practices. Furthermore, my research addresses issues specific to the eighteenth- and nineteenth-century silk industry, to the eighteenth-century British political economy and trade, and to the English East India Company. This research fills in a gap in the literature by focusing on silk production and consumption. It also links the silk industry to debates on development, the great divergence, trade and global technology transfers.

The project situates the late eighteenth-century development of the Bengal silk industry into the context of the EEIC's policies after it gained political and administrative power over Bengal in 1757. The analysis of the Company's silk manufacturing activities develops a more comprehensive picture of the Company's role in the pre-modern world economy and contributes to research on the economic role of the European trading companies. The project points to the EEIC's agency in order to accommodate raw silk production in Bengal to the demands of the British silk weaving sector. Bengal raw silk attracted the interest of the European trading companies from the seventeenth century. However, this trade was hindered by the low quality of the silk. In contrast to the cotton industry, eighteenth-century Indian silk production was not at the cutting edge of technology. Bengal raw silk was considered too coarse and unequal in skeins to be used by European silk manufactures and weavers.

My thesis puts forward two main arguments. First, it argues that the EEIC decided to expand its trade in Bengal raw silk in the late eighteenth century as part of its efforts to transfer its Indian territorial revenues to Britain.[4] In most of the Company's correspondence and other documents from the 1760s-70s, raw silk was considered to be

[4] Huw V. Bowen, *Revenue and Reform: The Indian Problem in British Politics, 1757-1813* (Cambridge: Cambridge University Press, 1991), p. 21.

one of the 'choicest' goods with potentially high returns.[5] A question arises: what underpinned these expectations and encouraged the Company to become a silk manufacturer in Bengal? My thesis argues that the EEIC's interest was induced by the British government's support of the domestic silk industry and also by changes to the EEIC's finance in the aftermath of the Battle of Plassey (1757) and the assumption of the dewani of Bengal, Bihar, and Orissa (1765). In this way the histories of the British and Bengal silk industries became intertwined.

Neither the British nor the Bengal silk industry were leaders in the production of silk items in the eighteenth century. Never a leader in international markets, the British silk industry specialised in the production of small wares and haberdashery. Yet thanks to Government support, British silk products were among the principal export goods of the British Isles from the seventeenth up to the beginning of the nineteenth century. The weaving sector was dependent on imports of raw silk and its consumption was far from trivial. Raw silk was quantitatively the most important raw material imported into Britain in the 1750s and 1760s.[6] This explains why the British government was keen to secure supplies of raw silk from British dominions. The EEIC could thus satisfy the demand of the British silk weavers with Bengal raw silk, especially as the Company was dependent on the export trade for transferring the dewani (tax revenues of Bengal, Bihar and Orissa) to Britain. In the 1760s and 1770s the EEIC considered the trade in Bengal raw silk as an essential channel for remitting these revenues.

[5] For instance IOR/E/4/621: 'Mr Wiss, Superintendent of Silk Trade', Bengal Despatches, 24 November 1772', India Office Records and Private Papers, pp. 379-80.

[6] B. R. Mitchell, *British Historical Statistics* (Cambridge: Cambridge University Press, 1988), p. 463. The imports of raw, thrown, and waste silk in the period 1750-60 surpassed even the imports of flax and hemp.

Second, my thesis argues that the adoption of the Piedmontese system of reeling did not produce the expected quality improvements due to a lack of attention paid to the organization of production. In spite of the adoption of new reeling technology, problems with the quality remained the single most important factor that curtailed the demand for Bengal raw silk on the British market. These problems with the quality of the silk were underscored by managerial problems which facilitated a focus on quantity rather than quality. My thesis shows that the EEIC's venture into Bengal silk production was an institutional failure. It explores how the success of the Piedmontese reeling system was undermined by institutional factors rather than by a lack of technical adaptations, knowledge of 'best practices' and the incompatibility of factor endowments. My research emphasises the importance of managerial practices, organization of production, and contracts aligning the incentives of agents with the aims of principals.

## Literature Review

My dissertation touches upon several historiographical bodies ranging from the history of the silk industry and the English East India Company, to mercantilism, and global history. First, I wish to consider the current state of research on the silk industry focusing on the technical aspects of silk thread production and on the dynamics of the global silk industry and trade in the eighteenth century. Second, I consider existing scholarship on the EEIC and the political economy of mercantilism which was central influence on the EEIC's policies in the eighteenth century. Finally, I conclude by outlining the main concepts and approaches of global history applied in this dissertation.

## **The Silk Industry**

The silk industry has never received as much scholarly attention as the cotton industry. Existing literature focuses predominantly on the history of silk production, consumption and silk textile designs in Europe, especially in Italy and France, and in China. For my dissertation the scholarship on the Indian and British silk industry is the most relevant. However, I supplement work on the Indian silk industry with literature on European silk industries to analyse topics such as technology transfers, adaptations, organization of production and quality enforcement missing from the research on India. In this section, I will first discuss the historiography of the Indian and British silk industries and then proceed with the discussion of the Italian, Chinese and French silk industries.

Indian silk industry has so far been little studied. Scholarly interest focused on the origins of sericulture and silk production and communities involved in silk weaving.[7] Several studies have similar focus as my thesis but concentrate on different geographical area. Maxine Berg has studied the unsuccessful attempt of the EEIC to set up silk production on the Coromandel Coast. This attempt never got as far as the one carried out in Bengal, since Coromandel Coast – which never had a tradition of silk production – proved to be unfit for silk industry. [8] Claudio Zanier has focused on human agency in fostering silk production in Western India a topic that my thesis also considers. Zanier has studied the unsuccessful experiments with silk production in the

[7] Vijaya Ramaswamy, 'Silk and Weavers of Silk in Medieval Peninsular India', *Medieval History Journal* 17 (1), 2014, pp. 145-69; Lotika Varadajan, 'Silk in Northeastern and Eastern India: The Indigenous Tradition', *Modern Asian Studies* 22 (3), 1988, pp. 561-70.

[8] Maxine Berg, 'Passionate Projectors: Savants and Silk on the Coromandel Coast 1780-1798', *Journal of Colonialism and Colonial History* 14 (3), 2013, pp. 1-24.

nineteenth century that were carried out by Giuseppe Mutti – a silk expert that we will encounter again in this thesis – with varying degrees of support from the EEIC.[9]

The literature pays particular attention to Bengal, the major centre of silk production in India in the early modern and modern periods.[10] The literature focuses mostly on trade and the role of merchants and on deindustrialisation in the nineteenth century. Rila Mukherjee and Sushil Chaudhuri have examined the position of silk merchants of India in the Bengal silk trade in the eighteenth century and concluded that their influence declined in the second part of the century.[11] Gautam Bhadra has studied the diffusion of EEIC's silk filatures in Bengal with a focus on the role of the Bengalese merchants.[12] Important contribution was made by Harbans Mukhia who observed that the Bengal reelers resisted the methods of winding implemented by the EEIC for

[9] Claudio Zanier, 'Silk Culture in Western India: The 'Mutti Experiment', 1830-47', *Indian Economic and Social History Review* 21 (4), 1984, pp. 464-97.

[10] Abhay Kumar Singh presents an overview of the development of Bengal silk production from Mughal times. Abhay Kumar Singh, *Modern World System and Indian Proto-Industrialization: Bengal 1650-1800* (Delhi: Swatantra Bharat Press, 2006), pp. 173-201.

[11] Rila Mukherjee, 'The Story of Kasimbazar: Silk Merchants and Commerce in Eighteenth-Century India', *Review Fernand Braudel Center* 17 (4), 1994, pp. 499-554; Rila Mukherjee, *Merchants and Companies in Bengal: Kasimbazar and Jugdia* (New Delhi: India Pragati Publications 2006); Sushil Chaudhury, 'International Trade in Bengal Silk and the Comparative Role of Asians and Europeans, circa. 1700-1757', *Modern Asian Studies* 29 (2), 1995, pp. 373-86.

[12] Gautam Bhadra noted that in the late eighteenth century most of the silk filatures were owned by the Company or English private proprietors. Only 18% of the total number of basins was in filatures owned by gomasta merchants. Gautam Bhadra, 'Silk Filature and Silk Production: Technological Development in the Early Colonial Context, 1768-1833', in Deepak Kumar (ed.), *Science and Empire: Essays in Indian Context, 1700-1947* (Delhi: Anamika Prakashan, 1991), pp. 59-87. Bhadra also focused on the role of Pykars – intermediary merchants that advanced payments to peasants and procured reeled silk and cocoons. Bhadra, Gautam, 'The Role of Pykars in the Silk Industry of Bengal (C.1765-1830)', *Studies in History* 3 (1), 1987, pp. 155-85; Bhadra, Gautam, 'The Role of Pykars in the Silk Industry of Bengal (C.1765-1830) Part 2', *Studies in History* 4 (1/2), 1988, pp. 1-35.

economic reasons as they were less profitable for reelers than the local methods.[13] Indrajit Ray has explored the Bengal silk industry in the period 1650-1875 and considered alternative hypotheses for the demise of the industry in the late nineteenth century.[14] Ray argues that the nineteenth-century decline of the industry was caused by the inability of the Bengal silk industry to catch up with the technological innovations of the sector at global scale. A more detailed picture of the Bengal silk industry was presented by Roberto Davini who studied the industry in his dissertation and several papers.[15] My dissertation differs from Davini's in two major aspects. My thesis considers for the first time how reeling practices impeded the success for the Company's plan. First, my dissertation is not a study of the general development of silk industry in the late eighteenth-century Bengal. In contrast to Davini, my research concentrates much more closely on the Company's role and on the factors that influenced the EEIC's project. Second, my thesis adopts an economic- and business-history approach. This approach allows me to consider several of the challenges that threatened the success of the Company's plan, mainly principal-agent problems, management practices, and governance. Davini's research focused mostly on sericulture. Thus, although the literature pays attention to the EEIC's involvement in the Bengal silk industry a complete study is missing.

The literature on the British silk industry is comparatively rich. The economic

[13] Mukhia, Harbans, 'Social Resistance to Superior Technology: The Filature in Eighteenth-Century Bengal', *Indian Historical Review* 11 (1/2), 1984, pp. 56-64.

[14] Indrajit Ray, 'The Silk Industry in Bengal during Colonial Rule: The 'De-Industrialisation' Thesis Revisited', *The Indian Economic and Social History Review* 42 (3), 2005, pp. 339-75.

[15] Roberto Davini, 'Una Conquista Incerta. La Compagnia Inglese delle Indie e la Seta del Bengala,1769-1833',(Unpublished PhD thesis: European University Institute, 2004). See also: Roberto Davini, 'A Global Supremacy: The Worldwide Hegemony of the Piedmontese Reeling Technologies, 1720s-1830s', in Anna Guagnini and Luca Molà (eds.), *History of Technology*, Vol. 32 (London: Bloomsbury Publishing, 2014), pp. 87-105; Id., 'Bengali Raw Silk, the East India Company and the European Global Market, 1770-1833', *Journal of Global History* 4 (1), 2009, pp. 57-79.

history of the British silk industry in the eighteenth and early nineteenth centuries was studied by Frank Warmer, Gerald Herz and J. H. Clapham who focused on system of production, regulation and the protection of the silk industry in London.[16] The regional distribution of silk production was explored by Gail Malmgreen, and Jean-Francois Fava-Verde.[17] Donald C. Coleman studied the history of the Courtalds – important producers of crape and later rayon.[18] Natalie Rothstein studied the designs and patterns of broad silk weaves made in Spitalfields in the eighteenth century, the only period when English broadweaving found international markets.[19] The nineteenth-century British silk industry was researched by J. A. Iredale and P. A. Townhill who examined silk spinning – the process of producing silk yarn from waste silk.[20]

The existing scholarship on the Indian and British silk industries, however,

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[16] Gerald B. Hertz, 'The English Silk Industry in the Eighteenth Century', *English Historical Review* 24 (96), 1909, pp. 710-27; J. H. Clapham, '"Spitalfields Acts", 1773-1824', *Economic Journal* 26 (104), 1916, pp. 459-71; Frank Warner, *The Silk Industry of the United Kingdom: Its Origin and Development* (London: Drane´s, 1921).

[17] Gail Malmgreen, *Silk Town: Industry and Culture in Macclesfield 1750-1835* (Hull: Hull University Press, 1985); Jean-Francois Fava-Verde, *Silk and Innovation: The Jacquard Loom in the Age of the Industrial Revolution* (Ebook: Histancia, 2011); Paul Knight, 'The Macclesfield Silk Button Industry: The Probate Evidence', *Textile History* 35 (2), 2004, pp. 157-77; Natalie Rothstein, 'Canterbury and London: The Silk Industry in the Late Seventeenth Century', *Textile History* 20 (1), 1989, pp. 33-47; Stanley Chapman, 'Vanners in the English Silk Industry', *Textile History* 23 (1), 1992, pp. 71-86.

[18] Donald C. Coleman, *Courtaulds: An Economic and Social History: The Nineteenth Century Silk and Crape* (Oxford: Clarendon Press, 1969), Vol. 1; Id., *Courtaulds: An Economic and Social History: Rayon* (Oxford: Clarendon Press, 1969), Vol. 2. Besides the history of the Courtalds also the history of another important silk producer was mapped – for the Berisfords see: Charles Berisford Sebire and J. F. Sebire, *Berisfords: The Ribbon People: The Story of a Family Business* (London: William Sessions Ltd., 1966).

[19] Natalie Rothstein. *Spitalfields Silk* (London: Stationary Office, 1975), pp. 1-2; Id., *Silk Designs of the Eighteenth Century: From the Collection of the Victoria and Albert Museum* (London: Thames and Hudson Ltd., 1990).

[20] J. A. Iredale and P. A. Townhill, 'An Early Silk Comb', *Textile History* 2 (1), 1971, pp. 57-64; J. A. Iredale and P. A. Townhill, 'Silk Spinning in England: The End of an Epoch', *Textile History* 4 (1), 1973, pp. 100-8. Silk spinning was studied also by Hollins Rayner earlier in the twentieth century. Hollins Rayner, *Silk Throwing and Waste Silk Spinning* (London: Scott, Greenwood & Co., 1908).

fails to address a series of key issues considered in my dissertation, such as for example, the attempts to accommodate the quality of the Bengal raw silk to British demand; the adaptation of Piedmontese technology, and the profitability of the transfer of these technologies to Bengal. This absence is partly due to the fact that the secondary literature only considers the silk industry through the adoption of national frameworks. More help seems to come from the literature on the technology and economic history of the Italian and Chinese silk industries.

Considering publications on the Italian silk industry the most significant contribution is the work of Luca Molà.[21] Molà studied the silk industry of Venice in the fifteenth and sixteenth centuries. At this time Venice was the largest silk producing area in Europe and Italian silk cloth dominated both European and Levantine markets. The study serves also as an important source of information on the Italian silk industry in general as it maps out the development of silk production in the Peninsula, as well as the principal factors of the dissemination of silk production, the trade in raw silk and the development of silk technologies. The study fills in a gap in the literature concerning the Italian silk industry and points to the important role of the silk industry in the

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[21] Molà, *Silk Industry*. For studies in Italian see for instance: Giuseppe Chicco, *La Seta in Piemonte 1650-1800: Un Sistema Industriale d'Ancien Regime* (Milan: Franco Angeli, 1995); Luca Molà, Reinhold C. Mueller, and Claudio Zanier (eds.), *La Seta in Italia dal Medioevo al Seicento: Dal Baco al Drappo* (Venice: Marsilio, 2000). An important historian of Italian and French silk industry is Carlo Poni, see for instance: Carlo Poni, *La Seta in Italia: Una Grande Industria Prima della Rivoluzione Industriale* (Bologna: Mulino, 2009); Carlo Poni, 'Fashion as Flexible Production: The Strategies of the Lyons Silk Merchants in the Eighteenth Century', in Charles F. Sabel and Jonathan Zeitlin (eds.), *World of Possibilities: Flexibility and Mass Production in Western Industrialization* (Cambridge: Cambridge University Press, 1997), pp. 37-74. Besides regional studies Carlo Poni also focused on problems in the regulation of the quality of silk thread. Carlo Poni, 'Standards, Trust and Civil Discourse: Measuring the Thickness and Quality of Silk Thread', *History of Technology* 23 (1), pp. 1-16. He also studied silk technologies: Carlo Poni, 'All'Origine del Sistema di Fabbrica: Tecnologie e Organizzazione Produttiva dei Mulini da Seta nell'Italia Settentrionale (secc. XVII-XVIII)', *Rivista Storica Italiana* 88 (3), 1976, pp. 444-97.

process of economic and technological development of Italy.[22] However, despite its significance in the early modern economy, the Italian silk industry remains an understudied field.[23] There is only one major study on the silk industry of Piedmont.[24] Mauro Ambrosoli has considered the Piedmontese systems of regulation and quality control. The most significant contribution to the understanding of the technological development of the Piedmontese silk production technologies have been made by Claudio Zanier.[25]

Some brief references should also be made to the Chinese, Japanese and French silk industries. The development of the Chinese silk thread and weaving production methods have been thoroughly examined by Dieter Kuhn.[26] Kuhn focuses on the factors that underpinned the position of China as the world leader in silk production in the early modern period.[27] The scholarship on the Japanese silk industry in the early

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[22] Molà, *Silk Industry*, pp. xv, xvi; xii-xix; 3-20, 55-8 and 186-214.

[23] Franco Franceschi studied silk production in fifteenth-century Florence and Carlo Poni in sixteenth- and seventeenth-century Bologna. Franco Franceschi, *Florence and Silk in the Fifteenth Century: The Origins of a Long and Felicitous Union* (Fiesole: Edizioni Cadmo, 1995); Carlo Poni, 'Comparing Two Industrial Districts: Bologna and Lyon in the Early Modern Period', in Pier Luigi Porta, Roberto Scazzieri, Andrew S. Skinner, *Knowledge, Institutions, and the Division of Labour* (Cheltenham: Edward Elgar, 2001), pp. 199-229.

[24] Chicco, *La Seta in Piemonte 1650-1800.*

[25] Mauro Ambrosoli, 'The Market for Textile Industry in Eighteenth Century Piedmont: Quality Control and Economic Policy, *Rivista di Storia Economica* 16 (3), 2000, pp. 343-64; Claudio Zanier, 'Pre-Modern European Silk Technology and East Asia: Who Imported What?', in Ma (ed.) *Textiles in the Pacific,* pp. 105-191.

[26] Dieter Kuhn, 'Textile Technology: Spinning and Reeling', in Joseph Needham (ed.), *Science and Civilization in China: Chemistry and Chemical Technology* (Cambridge: Cambridge University Press, 1988), Vol. 5, Part 9. See also Dieter Kuhn (ed.), *Chinese Silks* (New York and London: Yale University Press, 2012).

[27] Mau Chuan-Hui and Gaines K. C also focus on the factors that underpinned Chinese technological leadership in silk production. Mau Chuan-Hui, 'Silk Industry: Technology and Human Capital Formation in France and China', (Paper Presented at the Conference: 'Epstein Memorial Conference: Technology

nineteenth century offers a wealth of information on transfers of silk technologies from Europe and the best direct comparison to the transfer of silk technologies to Bengal.[28] The scholarship on the French silk industry focuses on weaving, design, fashion, marketing and industrial espionage as a vehicle for transmitting technologies with a specific focus on Lyon.[29] Scholarship pays little attention to raw silk production as France was not the leader in silk thread production in the early modern period.

## **Processes of Silk Thread Production**

This dissertation focuses primarily on the process of silk reeling. Silk is a natural fibre which originates as a filament. In order to be used in the textile industry it has to be first processed into raw silk or, in other words, silk thread (Figure I.1). Only after obtaining raw silk, can the thread be woven. The main stages of silk textile production are therefore: sericulture, silk reeling, throwing, weaving, dyeing and finishing.

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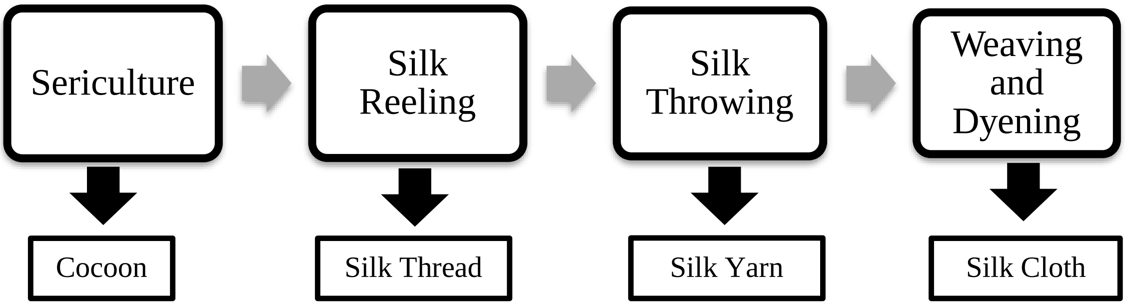
and Human Capital Formation', London, June, 2008), pp. 1-20; Gaines K. C. Liu, 'The Silkworm and Chinese Culture', *Osiris* 10, 1952, pp. 124-94.

[28] For the Japanese silk industry see: Tessa Morris-Suzuki, 'Sericulture and the Origins of Japanese Industrialization', *Technology and Culture* 33 (1), 1992, pp. 101-21; Yukihiko, Kiyokawa, 'Transplantation of the European Factory System and Adaptations in Japan: The Experience of the Tomioka Model Filature', *Hiotsubashi Journal of Economics* 28 (1), 1987, pp. 27-39. Claudio Zanier points to the fact that the initial success of the Japanese silk exports was underpinned by the decline of raw silk production in Europe caused by the pebrine disease. Claudio Zanier, 'Japan and the 'Pébrine' Crisis of European Sericulture during the 1860s', *Bonner Zeitschrift für Japanologie* 8, 1986, pp. 51-63.

[29] See for instance: Lesley Miller, 'Material Marketing: How Lyonnais Silk Manufacturers Sold Silks, 1660-1789', in Jon Stobart and Bruno Blondé (eds.), *Selling Textiles in the Long Eighteenth Century: Comparative Perspectives from Western Europe* (Basingstoke: Palgrave Macmillan, 2014), pp. 85-98; Id., 'La Cultura de la Manufacture: Les Marchands Fabricants', in Maria-Anne Privat-Savigny (ed.), *Lyon au XVIIIe Siècle: Un Siècle Surprenant!* (Lyon: Musée Gadagne/Sogomy, 2012), pp. 109-21; Paola Bertucci, 'Enlightened Secrets: Silk, Intelligent Travel, and Industrial Espionage in Eighteenth-Century France', *Technology and Culture* 54 (4), 2013, pp. 820-52.

**Figure I.1. Phases of Silk Production**




Sericulture covers the cultivation of mulberry trees, picking mulberry leaves, raising silkworms, and the harvesting of cocoons (Figure I.2). The quantity of leaves produced by a mulberry tree depends on its species, on the system of cultivation and manuring, and on climate.[30] The cultivation of mulberry trees can be combined with the cultivation of other crops. In Europe, sericulture used to be combined with gardening, tobacco and fruit cultivation.[31] Silk filaments are produced by the larvae of the domesticated moth Bombyx mori when forming a cocoon.[32] In Europe Bombyx mori is 'monovoltine', meaning that it creates only one generation of larvae per year. In Bengal, by contrast, there can be between 5 and 7 crops of silkworms per year. After hatching, the larvae spends the next 35 days feeding on mulberry leaves. Therefore abundant supplies of fresh mulberry leaves are crucial for this first stage. The silkworms need to be fed continuously with fresh leaves in order to prevent them from contracting disease.

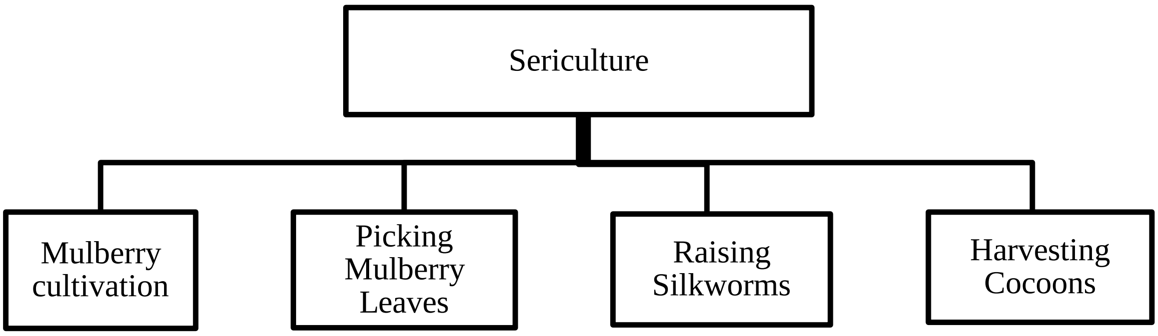
[30] Pruning, manuring and disease control are essential for a good harvest of high-quality mulberry leaves. Joseph Schober, *Silk and Silk Industry* (London: Constable & Co Ltd., 1930), pp. 17 and 19.

[31] Ibid., p. 17.

[32] The majority of silk filaments used in the silk industry are produced by *Bombyx mori* larvae. Smaller quantities of silk are also produced from filaments secreted by non-domesticated moths. This silk is called wild silk and its principal kinds are: *tussah* or *tasar* (native to Southern India and China, an uneven, stiff silk with a glass lustre), yama-mai (in Japan, most similar to mulberry silk), *eri* or *eria* and *fogara* (from Eastern India, which can only be spun, not thrown). Schober, *Silk and Silk Industry*, pp. 20-21.

Silkworms have to be kept in hygienic conditions.[33] This is achieved by placing the leaves on trays that are regularly changed. Mature silkworms form cocoons which are made from a single silk filament.[34] The worm then turns into a chrysalis and after few weeks into a moth. Since the moth can destroy the cocoon, the chrysalis has to be killed before the metamorphosis is completed.[35]

**Figure I.2. Phases of Sericulture**




The next step is reeling: the unwinding of cocoons and the preparation of the silk thread.[36] Cocoons are placed in a basin of water heated to high temperature.[37] Water softens sericin – the substance that binds the cocoons together – and the cocoons unwind into single long filaments. Five to twenty of these filaments are then drawn together with the use of a reeling machine or hand reel. Reeled silk thread is then dried and sericin binds the filaments together again.[38] These principles of silk thread production practically did not change since the early modern period.

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[33] Richard Hills, 'From Cocoon to Cloth: The Technology of Silk Production', in Simonetta Cavaciocchi (ed.), *La Seta in Europa Secc. XIII-XX* (Prato: Istituto Internazionale di Storia Economica, 1993), pp. 61-62.

[34] Schober, *Silk and Silk Industry*, pp. 14-15.

[35] Hills, 'From Cocoon to Cloth', p. 62.

[36] Ibid., p. 65.

[37] The temperature to which water was heated in the early modern period varied. The current recommendation is 75°-80° C.

[38] A single cocoon would not give a thread of sufficient strength. Ibid., pp. 65 and 67-69.

Although the EEIC only got involved in sericulture and silk reeling in Bengal, the process of silk throwing is important because in the late 1790s the Company started throwing the Bengal silk in Britain. Throwing is a term used for the operations of twisting and doubling by which fine raw silk threads are turned into more substantial silk yarns. This process is often necessary because silk thread is typically too fine for weaving. The number of threads that are doubled together and the amount of twist applied is determined by the type of fabric to be produced from the yarn.[39] The main types of thrown silk used in weaving are tram, crêpe yarn and organzine. Trams are used as wefts and are formed of two or more threads twisted with five to ten twists per inch. Crêpe yarn has a heavier twist with fifty to eighty turns per inch. Organzine has a very high twist and is mostly used for warps. The thread is first twisted, then doubled two-, three-, or four-fold, and then twisted again in the opposite direction of the first twisting.[40] Organzine is considered the highest-quality silk yarn and has the highest twist.[41]

## A Global Overview of the Development of the Silk Industry

By the eighteenth century, silk had been produced for several centuries. However, the knowledge and technologies of silk production differed across world regions: China, Italy, and France were leaders in the sector.[42] By this time the silk industry was already

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[39] Silk and Rayon User's Association, *The Silk Book* (London: Silk and Rayon User's Association, 1951), p. 28; Hills, 'From Cocoon to Cloth', p. 67.

[40] William S. Murphy, *The Textile Industries: A Practical Guide to Fibres, Yarns, and Fabrics in Every Branch of Textile Manufacture, Including Preparation of Fibres, Spinning, Doubling, Designing, Weaving, Bleaching, Printing, Dyeing and Finishing* (London: Gresham, 1912), pp. 174-75; Silk and Rayon User's Association, *The Silk Book*, p. 28; Hills, 'From Cocoon to Cloth', p. 67-69.

[41] Murphy, *Textile Industries*, p. 175.

[42] Zanier, 'Pre-Modern European Silk Technology and East Asia', p. 113.

an established sector in most Asian and European economies.[43] Production areas were, however, concentrated only in a few regions. Among the most important areas of silk production in the seventeenth and eighteenth centuries were Jiangning, Suzhou and Hangzhou in China; Bengal, Kashmir and Gujarat in India; Levant; Transcaucasia in Persia; Florence, Lucca, Piedmont and Venice in Italy; Lyon and Tours in France; and Spitalfields, Macclesfield and Coventry in England.[44] The fact that the list of significant producers did not alter substantially over the seventeenth and eighteenth centuries, does not mean that the market leaders remained unchanged over time. The global silk industry was a competitive sector in which constant technological innovation, innovations in the organization of labour and skill-upgrading was essential for continued market success.[45]

The types of silk fabric and quantity of products manufactured varied between producers. In the seventeenth and eighteenth centuries, Italy and France were at the technological forefront of silk production in Europe.[46] Their expertise was based on human capital formation and technological innovation. Since the thirteenth century, Italy had been the leader in the market for finished silks and since the fifteenth and sixteenth centuries also in the production of the highest quality raw silk.[47] Italy pioneered new techniques of silk throwing using the flyer-wheel and bobbin as well as

[43] Federico, *Economic History of Silk Industry*, p. 4.

[44] Shelagh, Vainker, *Chinese Silk: A Cultural History* (New Brunswick: The British Museum Press, 2004), p. 172; Mark Steele, 'The Comparative Economics of Government and Guild Regulation in the European Silk Industry in the Early Modern Period', in Cavaciocchi (ed.) *La Seta in Europa*, p. 201.

[45] Zanier, 'Pre-Modern European Silk Technology and East Asia', p. 113.

[46] Ernest Pariset, *Les Industries de la Soie* (Lyon: Imprimerie Pitrat Ainé, 1890), pp. 323-48.

[47] Zanier, 'Pre-Modern European Silk Technology and East Asia', p. 114; Molà, *Silk Industry*, pp. 3-5.

water-powered twisting mills.[48] Moreover, a new system of silk reeling was established in Piedmont in the middle of the seventeenth century and the region became the leader in the production of high-quality silk yarn known as organzine.[49] France established its silk industry in the fifteenth century and due to technological innovations overtook its competitors by the beginning of the nineteenth century.[50] Lyon became known as the silk weaving capital of Europe and set fashion.[51] France particularly excelled in weaving techniques for the production of figured fabrics, leading to the 1801 invention of the Jacquard loom.[52]

In Asia, the market leader was China, the cradle of the silk manufacturing. China produced silk fabrics primarily for its domestic market but also traded silk fabrics and raw silk in exchange for metals and other commodities.[53] Finished silks from China were highly praised and Chinese silk thread was as well regarded as Piedmontese silk. Until the seventeenth century, China was the world innovator in silk technologies and thus, stimulated catching up processes in the European silk industry.[54] Reeling technologies invented as early as the Song period (960-1127) allowed China to produce the finest and thinnest silk thread until the "Piedmontese revolution" of the seventeenth

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[48] Hills, 'From Cocoon to Cloth', p. 69; Robert Patterson,'Spinning and Weaving', in Charles Singer (ed.), *A History of Technology II: The Mediterranean Civilizations and the Middle Ages,700 BC - 1500 AD* (Oxford: Clarendon Press, 1956), p. 207.

[49] Zanier, 'Pre-Modern European Silk Technology and East Asia', pp. 142 and 146-49; Roberto Davini, 'The History of Bengali Raw Silk as Interplay between the Company Bahadur, the Bengali Local Economy and Society, and the Universal Italian Model, c.1750 – c.1830', *Commodities of Empire Working Paper* 6 (2008), pp. 5-7

[50] Chuan-Hui, 'Silk Industry', pp. 1-2.

[51] Miller, 'Material Marketing', pp. 87-88; Luce Boulnois, *The Silk Road* (London: George Allen & Unwin Ltd., 1963), pp. 212-13; Zanier. 'Pre-Modern European Silk Technology and East Asia', p. 118.

[52] Robert Flanagan, 'Figured Fabrics', in Charles Singer (ed.), *A History of Technology III: From Renaissance to the Industrial Revolution, 1500 – 1750* (Oxford: Clarendon Press, 1957), p. 106.

[53] Dennis O. Flynn and Arturo Giraldez, 'Silk for Silver: Manila Macao-Nagasaki Trade in the 17th Century', in Ma (ed.), *Textiles in the Pacific*, pp. 33-36.

[54] Zanier. 'Pre-Modern European Silk Technology and East Asia', pp. 114-15 and 142.

century.[55] China remained a world leader in sericulture until the nineteenth century.[56] Only in the nineteenth century did the European silk industry overtake the Chinese thanks to the adoption of new scientific methods including the use of microscopes to examine the quality of cocoons.[57]

The silk industries of India and Britain were not at a similar level of development as France, Italy or China in the seventeenth and eighteenth centuries. Both India and Britain lagged behind in terms of the technologies used and in respect to human capital formation.[58] However, both countries produced silks for their respective domestic markets. Britain focused on smaller wares such as ribbons and lower quality goods. The British silk industry benefited from the migration of French weavers in response to the Revocation of Edict of Nantes in 1685.[59] Nevertheless, during the eighteenth century the industry was not able to keep pace with the technological development of its competitors and had to be supported through state protection.[60]

Until the nineteenth century, when the method of drying cocoons was finally developed, silk reeling had to be located in the same place as sericulture.[61] Without drying cocoons got easily spoilt which precluded long distance trade. The factors determining the location of sericulture and silk reeling were similar until the nineteenth century – the low value added made labour costs and transport costs decisive factors.[62]

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[55] Ibid., pp. 142-45.

[56] Ibid., p. 142.

[57] Ibid., p. 110.

[58] Mulberry sericulture was introduced to India only in the fourteenth or fifteenth centuries. Sanjay Shinha, *The Development of Indian Silk Industry: A Wealth of Opportunities* (London: Intermediate Technology Publications, 1990), pp. 4-5. Warner, *The Silk Industry of the United Kingdom*, pp. 35-43.

[59] Ibid., pp. 35-43.

[60] Moira Thunder, *Spitalfields Silks: V&A Pattern* (London: V&A Publishing, 2011), p. 4.

[61] Claudio Zanier, 'The Migration of the Silk Cycle from China: A Comprehensive View', in Molà and Schäfer (eds.), *Threads of Global Desire*.

[62] Federico, *Economic History of Silk Industry*, pp. 16-18.

Yet, it was not only just a matter of finding cheap labour, workers have to possess the manual dexterity to produce high-quality thread.[63]

Trade became an important feature of the global silk industry earlier than in other sectors. The high value of silks combined with their low volume made trade economically viable thus overcoming what Ferdinad Braudel calls the "tyranny of distance".[64] The combination of high prices and demand for silk was an incentive to establish a domestic silk industry. However since many regions did not have the climatic conditions favourable for sericulture, trade in raw silk and silk textiles expanded to meet the demand.[65]

Due to sericulture's dependence on climatic conditions, silk cultivation in Europe was restricted mostly to the Iberian peninsula, Italy, southern France, Albania and Greece.[66] The importation of raw silk to Europe had a long tradition starting from before the fifteenth century when silk weaving expanded north of the Alps to France. With the rise of the northern European silk weaving industries in the sixteenth and seventeenth centuries, the continent's production of raw silk could no longer satisfy internal demand.[67] This encouraged the East India companies to search for new suppliers in East and South Asia.[68] In particular, the British silk industry was heavily dependent on imports of raw silk. During the seventeenth and eighteenth centuries, the majority of the raw silk imported into Britain came from Turkey and Italy. Sensing a profit opportunity, the EEIC attempted to substitute these imports with Bengal raw

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[63] In this respect the situation was the same in Asia and in Europe. Ibid., p. 20.

[64] Ferdinand Braudel, *Civilization and Capitalism, 15th-18th Century: The Structures of Everyday Life* (Los Angeles: University of California Press, 1992) , Vol. 1, p. 429; Ma, 'Great Silk Exchange', p. 1.

[65] Ma, 'Great Silk Exchange', p. 4

[66] Boulnois. *Silk Road*, pp. 211-12.

[67] Federico, *Economic History of Silk Industry*, pp. 4-5; Boulnois, *Silk Road*, p. 214.

[68] Federico, *Economic History of Silk Industry*, p. 34.

silk.[69] This decision was supported by the political situation in Asia – especially after 1750 when Bengal fell under the control of the EEIC.[70]

## The English East India Company

The scholarship on the EEIC is vast and has been steadily growing over the past twenty years. The resurgence of interest in the Company's history is the result of developments in New Imperial History as well as, the interest in globalization and in transnationalism.[71] The foundations of the study of the commercial and maritime history of the EEIC were laid most notably by K. N. Chaudhuri and Niels Steensgaard.[72] In the 1970s and 1980s the Company came to be studied within the framework of the British political economy: particular attention was paid to the Company's role in state formation and in creating fiscal capacity.[73] A decade ago David Cannadine observed

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[69] Goldsmiths' Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London, n.p., 1795), p. 1.

[70] Boulnois, *Silk Road*, pp. 218-20; Federico, *Economic History of Silk Industry*, p. 34.

[71] Philip J. Stern, 'History and Historiography of the English East India Company: Past, Present, and Future!', *History Compass* 7 (4), 2009, p. 1146.

[72] K. N. Chaudhuri, *The Trading World of Asia and the English East India Company, 1660–1760* (Cambridge: Cambridge University Press,1978); Niels Steensgaard, *The Asian Trade Revolution of the Seventeenth Century: The East India Companies and the Decline of the Caravan Trade* (Chicago: University of Chicago Press, 1973).

[73] For the influence of the EEIC on state formation in Britain see for instance: John Brewer, *Sinews of Power: War, Money, and the English State* (New York, NY: Alfred A. Knopf, 1989); Bruce G. Carruthers, *City of Capital*: *Politics and Markets in the English Financial Revolution* (Princeton: Princeton University Press, 1996), pp. 137-60; Michael Braddick, *State Formation in Early Modern England, c.1550–1700* (Cambridge: Cambridge University Press, 2000); Steve Pincus, 'The Making of a Great Power? Universal Monarchy, Political Economy, and the Transformation of English Political Culture', *European Legacy* 5 (4), 2000, pp. 531–45; Steve Pincus, 'Whigs, Political Economy, and the Revolution of 1688–89', in David Womersley, Paddy Bullard and Abigail Williams (eds.), *'Cultures of Whiggism': New Essays on English Literature and Culture in the Long Eighteenth Century* (Newark, DE: University of Delaware Press, 2005), pp. 62-82.

how scholars had started to approach the EEIC not only from national or European perspectives but also from imperial and global viewpoints.[74]

The business history scholarship on the EEIC is particularly important for this dissertation. Business historians consider the EEIC as the precursor to modern multinational firms and have studied the Company's organization and trade systems.[75] Yet, when the EEIC is discussed in economic and business history literature, it is usually with regard to its trading activities. Historians such as K. N. Chaudhuri, Om Prakash and Tirthankar Roy emphasize the Company's role in expanding intra-Asian and Eurasian trade.[76] As a joint-stock company, it altered the way business was carried out "pioneering the shareholder model of corporate ownership and building the foundation of modern business administration".[77] As Roy observes, the Company acted as "an agent of change in transforming the business and politics in South and East Asia".[78] In the second part of the eighteenth century it conquered vast regions of South

[74] David Cannadine, '"Big Tent" Historiography: Transatlantic Obstacles and Opportunities in Writing the History of Empire', *Common Knowledge* 11 (3), 2005, pp. 379-80.

[75] Bruce Buchan, 'The Emergence of the Technostructure: Lessons from the East India Company, 1713–1836', *Journal of Management History* 41 (1), 2003, pp. 105–16; Ann M. Carlos and Stephen Nicholas, 'Giants of an Earlier Capitalism: The Chartered Companies as Modern Multinationals', *Business History Review* 62 (3), 1988, pp. 398-419; Ann M. Carlos and Stephen Nicholas, 'Theory and History: Seventeenth-Century Joint-Stock Chartered Trading Companies', *Journal of Economic History* 56 (4), 1996, pp. 916-24; Santhi Hejeebu, 'Contract Enforcement in the English East India Company', *Journal of Economic History* 65 (2), 2005, pp. 496–523.

[76] Tirthankar Roy, *The East India Company: The World´s Most Powerful Corporation* (London: Allen Lane, 2012), p.1.; Chaudhuri, *Trading World of Asia*, pp. 10-15; Om Prakash. *European Commercial Enterprise in Pre-Colonial India* (Cambridge: Cambridge University Press, 1998), pp. 268-315.

[77] Nick Robins, *The Corporation that Changed the World: How the East India Company Shaped the Modern Multinational* (London: Pluto Press, 2012), p. xxii.

[78] Roy, *East India Company*, p. 1; Chaudhuri, *Trading World of Asia*, pp. 131-45; Prakash, *European Commercial Enterprise in Pre-Colonial India*, pp. 315-37.

and East Asia.[79] Gradually, the Company started to rule the Indian subcontinent, establishing itself as a colonial power.[80] The requisite political and administrative power over the Indian subcontinent further expanded the possibilities of the Company to shape the region's development. Overall, the literature has focused on the Company as a power structure and considered the role of the EEIC in the conquest of South and East Asia.[81] Likewise the scholarship has discussed the Company's influence on the development of India.[82]

The role of the EEIC in manufacturing has been largely overlooked. In the late eighteenth century, the EEIC started to directly influence the political and economic development of the Indian subcontinent. Furthermore, in Bengal the EEIC assumed the role of a silk manufacturer. This thesis shows that the EEIC's involvement in production created new management and organizational challenges that necessitated different solutions to those adopted in the export trade.

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[79] Anthony Wild. *The East India Company: Trade and Conquest* (London: Harper Collins Illustrated, 1999), pp. 130-41.

[80] Roy, *East India Company*, p. 2.

[81] For a short overview of the EEIC's military activities in India see, for instance: Wild, *East India Company: Trade and Conquest*, pp. 130-141. The scholarship also considers the role of the EEIC in establishing colonial rule in India as considered for example by: Douglas M. Peers, 'Gunpowder Empires and the Garrison State: Modernity, Hybridity, and the Political Economy of Colonial India circa 1750–1860', *Comparative Studies of South Asia, Africa, and the Middle East* 27 (2), 2007, pp. 245-47 and C. A. Bayly, *The Birth of the Modern World, 1780-1914* (Oxford: Blackwell, 2004), p. 259.

[82] There are two strands in the development debate considering the impact of the Company' s rule and colonial rule in general on Indian development. The first argues that during the Company's rule, development of India was hampered. It is argued that economic prosperity was hindered by extractive institutions, or alternatively, by the creation of a "fragmented multiclass state with sluggish economy". The second strand argues for both positive and negative changes. Negative impacts were discussed for instance by Daron Acemoglu, Simon Johnson, James A. Robinson, 'Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution', *The Quarterly Journal of Economics* 117 (4), 2002, pp. 1231-291; Atul Kohli, *State Directed Development: Political Power and Industrialization in the Global Periphery* (Cambridge: Cambridge University Press, 2004), pp. 221-57. For a more balanced views see for instance: Roy, *East India Company*, pp. 188-222.

The viability of the silk trade was shaped by the context of the British political economy in the seventeenth and eighteenth centuries. During this period market forces operated in the framework of mercantilist regulations and pressure group politics.[83] British legislation was informed by Parliament's concern about the outflow of bullion and was influenced by petitions from the main industries. These two factors made the silk industry a strategic industry protected against competition with imported silks.

The import of finished silks was restricted in the eighteenth century with the aim of substituting them with domestic production.[84] The balance of payments and the promotion of employment were also referred to by contemporary pamphleteers and petitioners who pointed to the threat that the EEIC's trade posed to national manufacturing interests. The EEIC drew on the same rhetoric emphasizing the need to promote domestic manufacturing and employment when attempting to gain acceptance of the importation of raw silk. As pointed out by Edmund Burke, the Company attempted to use trade in raw silk to make its trading activities more appealing to the British mercantilist state and manufactures by claiming an important role in supplying British manufacturers with raw materials.[85]

Recent literature on mercantilism and its economic policies has focused on the role of the state in facilitating economic development.[86] Recent interest in mercantilism

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[83] Patrick O´Brien, Trevor Griffiths, Philip Hunt, 'Political Components of the Industrial Revolution: Parliament and the English Cotton Textile', *Economic History Review* 46 (3), 1991, pp. 395-423, and especially p. 396.

[84] David Omrod, *The Rise of Empires: England and the Netherlands in the Age of Mercantilism, 1650-1770* (Cambridge: Cambridge University Press, 2003), p. 168; Harky G. Johnson, 'Mercantilism: Past, Present and Future', *The Manchester School* 42 (1), 1974, p. 3.

[85] Edmund Burke, *The Works of the Right Honourable Edmund Burke,* (Boston: Wells and Lilly, 1826), Vol. 4, p. 68.

[86] The literature interpreted mercantilism in several ways, Rssner lists the possible approaches: "the Midas fallacy (Adam Smith) meaning the confusion of money and wealth; the unifying state system (Eli Heckscher); mercantilism as state building (Gustav Schmoller); mercantilism as an economic discourse

has been sparked by the works of Ha-Joon Chang, Erich S. Reinert, Prasannan Parthasarathi, and others who point to import substitution policies and measures to promote domestic manufacturing as decisive for economic growth.[87] The EEIC's plan to expand the exports of Bengal raw silk perfectly fit the contemporary mercantilist political economy. Although, some scholars still dispute that mercantilism was a 'closed' theory, the Company seemed to be very well aware of the contents of the doctrine.[88] Mercantilism has never been a doctrine with precisely defined policies. Lars

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(Lars Magnusson); mercantilism as rent-seeking society (Robert B. Ekelund and Robert D. Tollison); mercantilism as development economics (Erich S. Reinert); finally the 'Jealousy of Trade' paradigm". For the purposes of this study the economic discourse is the most important because it reflects the way in which the EEIC understood mercantilism and the way the Company applied the concept to both the British and Bengalese silk industries. Rssner, 'Heckscher Reloaded', p. 668; Adam Smith, *An Inquiry into the Wealth and Poverty of Nations* (University of Pennsylvania: An Electronics Classics Publication, 2005); Eli F. Heckscher, *Mercantilism* (London: George Allen and Unwin, 1955); Gustav Schmoller, *The Mercantile System and Its Historical Significance: Illustrated Chiefly from Prussian History: Being a Chapter from the Studien ueber die Wirthschaftliche Politik Friedrichs des Grossen* (New York: Macmillan, 1896); Robert B. Ekelund and Robert D. Tollison, *Mercantilism as a Rent-Seeking Society: Economic Regulation in Historical Perspective* (College Station, TX: Texas A&M University Press, 1981); Erich S. Reinert. *Why Rich Countries Got Rich and How Poor countries Stay Poor* (London: Constable, 2007).

[87] The authors favour heterodox approaches to economics rather than neoliberal or neoclassical ones. They argue that developing countries need to practice import substitution policies and have generally active economic policies to counter under-development. They support their argument by examples of European countries which followed such policies in the pre-modern era and/or during the first Industrial Revolution. Reinert, *Why Rich Countries Got Rich*, pp. 21-100; Ha-Joon Chang, *Kicking Away the Ladder: Development Strategy in Historical Perspective* (London: Anthem, 2002), pp. 19-53; Prasannan Parthasarathi, 'Great Divergence: Article Review', *Past and Present* 176 (1), 2002, pp. 290-93; Justin Lin and Ha-Joon Chang, 'Should Industrial Policy in Developing Countries Conform to Comparative Advantage or Defy It? A Debate Between Justin Lin and Ha-Joon Chang', *Development Policy Review* 27 (5), 2009, 482-502; Prasannan Parthasarathi, *Why Europe Grew Rich and Asia Did Not: Global Economic Divergence, 1600-1850* (Cambridge: Cambridge University Press, 2011), pp. 132-34; Joseph Inikori. *Africans and the Industrial Revolution* (Cambridge: Cambridge University Press, 2002), pp. 151 and 449.

[88] Considering the debate about mercantilism as theory Philipp Robinson Rssner observed that not even contemporary economic theories can be considered as closed ones. Philipp Robinson Rssner, 'Heckscher Reloaded? Mercantilism, the State, and Europe's Transition to Industrialization, 1600-1900', *Historical*

Magnusson argues that for these reasons mercantilism needs to be recognised as a discourse encompassing a range of perspectives presented in contemporary pamphlets, tracts and books.[89] In spite of the wealth of arguments presented in contemporary mercantilist literature, Magnusson observes that the majority emphasizes the promotion of export-led growth as a key concept favoured by mercantilist governments.[90] This was achieved through measures to support domestic industry, principally the manufacturing sectors.

In Britain, manufacturing was supported by limits and bans on the imports of finished products, and the promotion of imports of raw materials, especially if they came from colonial settlements.[91] Policies facilitating the British silk industry fitted well contemporary import-substitution policies. Eighteenth-century long-distance trade also featured prominently in this mercantilist environment. Colonial settlements played an important role as sources of raw materials and as markets for the export and/or re-

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*Journal* 58 (2), 2015, pp. 665 and 668. See also Alessandro Roncaglia, *The Wealth of Ideas: A History of Economic Thought* (Cambridge: Cambridge University Press, 2005). For the criticism of the term 'mercantilism' see, for instance: Lars Magnusson, *Mercantilism: Shaping of an Economic Language* (London: Routledge, 1994).

[89] Gerard Malynes, *A Treatise of the Canker of Englands Common Wealth* (London: Richard Field, 1601); Gerard Malynes, *The Maintenance of Free Trade, According to the Three Essential Parts of Traffique: Namely Commodities, Moneys and Exchange of Moneys, by Bills of Exchange for Other Countries* (London: William Shefford, 1622); Thomas Mun, *England's Treasure by Forraign Trade, or the Balance of our Forraign Trade is the Rule of our Treasure* (London: J.G, 1664); Josiah Child, *Brief Observations Concerning Trade and Interest of Money* (London: Henry Mortlock, 1668); James Steuart, *Inquiry into the Principles of Political Economy: Being an Essay on the Science of Domestic Policy in Free Nations* (London: A. Millax & T. Cadell, 1767).

[90] Magnusson, *Mercantilism*, pp. 74, 96, 109 and 174.

[91] Mercantilist approaches to economic policies were not unchanging over the eighteenth century. However, mercantilist economic policies in respect to British silk industry were fairly stable and followed the pattern described for manufacturing in general. British industry was supported by the systems of taxation, bans on imports, tariffs, etc. Peer de Vries, *State, Economy and the Great Divergence: Great Britain and China, 1680s-1850s* (London: Bloomsbury, 2015), p. 431.

export of finished goods.[92] Textiles were often the target of import prohibition.[93] The import of finished silk textiles was banned by the 1699, 1702 and 1720 legislation in order to support domestic production.[94] British silk production can be considered one of the major eighteenth-century import substitution projects, even though it failed.[95]

## Global History

The rise of global history in the past twenty years is also important for this thesis. Global history has its roots in the work of Fernand Braudel and Immanuel Wallerstein and its rise was marked by the publication of Kenneth Pomerantz's *Great Divergence* in 2000.[96] Research on the great divergence focuses on the study of the factors that

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[92] Josiah Child, *A Supplement to a Former Treatise Concerning the East-India Trade* (London: n. p., 1689), p. 12; Thomas Papillon, *A Treatise Concerning the East-India Trade: Being a Most Profitable Trade to the Kingdom, and Best Secured and Improved by a Company and a Joint-Stock* (London: n.p., 1680), p. 3; Joshua Gee, *The Trade and Navigation of Great-Britain Considered: Shewing, that the Surest Way for a Nation to Increase in Riches, Is to Prevent the Importation of Such Foreign Commodities as May Be Raised at Home* (London: Sam Buckley, 1729), pp. 1-23.

[93] Magnusson, *Mercantilism*, pp. 60-61.

[94] Chaudhuri, *Trading World of Asia,* p. 344.

[95] Different view of the pre-modern import substitution policies is taken by Maxine Berg. In her view, the encounter with the superior production of Asia brought about processes of learning, emulation and adaptation and thus facilitated market development, product development and technological change. Maxine Berg, 'In Pursuit of Luxury: Global History and British Consumer Goods in the Eighteenth Century', *Past and Present* 182 (1), 2004, pp. 85-142. From this point of view, the failure of the British silk industry to innovate is connected to the lack of competitive pressure.

[96] Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II* (Berkeley: University of California Press, 1995), Vol. 2. The world-system theory proposed by Wallerstein acknowledges the interconnectedness of world history and focuses on the globe as a whole rather than on one state or a region. Immanuel Wallerstein, *The Modern World-System I: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century* (New York: Academic Press, 1974); Id., *The Modern World System II: Mercantilism and the Consolidation of the European World-Economy, 1600-1750* (New York: Academic Press, 1980); Id., *The Modern World Systems III: The Second Era of Great Expansion of the Capitalist World-Economy, 1730-1840s* (San Diego: Academic Press, 1989); Id., *The Modern World Systems IV: Centrist Liberalism Triumphant, 1789-1914* (Berkeley: University of

underpinned the economic divergence between the West and the rest of the world in the late eighteenth and early nineteenth century.[97] This is not a new debate but global history has allowed scholars to approach it from a different angle and instead of focusing on Europe's exceptionalism, it focuses predominantly on studying global connections and on making comparisons.

Markus Vink mentions the important contribution of the Mediterranean, Atlantic and Pacific Ocean studies to global history.[98] The works of Fernand Braudel on Mediterranean world, Bernard Bailyn on Atlantic world, K. N. Chaudhuri and Ashin Das Gupta on Indian Ocean world presented new ways of thinking about connections and preceded global history.[99] These works gave stimulus to new debates and research on wider topics and areas. Especially Chaudhuri's study *The Trading World of Asia and the English East India Company, 1660-1760* had an important effect on the way scholars consider commodity trade. Chaudhuri explored the trade between India and Britain in a broader framework and also considered the influence of Indian merchants.

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California Press, 2011); Kenneth Pomerantz, *The Great Divergence: China, Europe, and the Making of the Modern World Economy* (Princeton: Princeton University Press, 2000).

[97] For major works on great divergence stressing European exceptionalism see for instance: Eric Jones, *The European Miracle: Environments, Economies and Geopolitics in the History of Europe and Asia* (Cambridge: Cambridge University Press, 1981); David S. Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present* (Cambridge: Cambridge University Press, 1969); Robert Allen, *The British Industrial Revolution in Global Perspective* (Cambridge: Cambridge University Press, 2009).

[98] Markus Vink, 'Indian Ocean Studies', *Journal of Global History* 2 (2007), pp. 41–62.

[99] Braudel, *Mediterranean and the Mediterranean World in the Age of Philip II*; Bernard Bailyn, *Atlantic History: Concept and Contours* (Cambridge, MA: Harvard University Press, 2005). For Indian ocean see: Chaudhuri, *Trading World*; Ashin Das Gupta and Michael Nyalor Pearson (eds.), *India and the Indian Ocean, 1500-1800* (Oxford: Oxford University Press, 1987); Ashin Das Gupta, *Indian Merchants and the Decline of Surat: circa 1700-1750* (Wiesbaden: Frany Steiner Verlag, 1979); Ashin Das Gupta, *Malabar in Asian Trade, 1740-1800* (London: Cambridge University Press, 1967).

One of the most prominent proponents of global history approach is Patrick O'Brien who recently reviewed the state of the discipline.[100] O'Brien has proposed that the globalizing world necessitates historiographies disengaged from national, regional, ethnic and religious traditions and argued that global history approach enables to portray differences and diversity.[101] Similar arguments were conveyed by Maxine Berg and the other scholars that contributed to the volume *Writing the History of Global* (2013).[102] The two most persuasive approaches to writing global history are based on studying connections or making comparisons. The study of connections has been pursued by William McNeil who argued that connections, encounters, and contacts are the real drivers of most changes – whether economic, social, political or cultural.[103] Many scholars followed this approach and focused their research on specific types of connections created through trade, investment, migration, warfare, spread of diseases etc.[104] The second approach focuses on writing comparative histories spanning different regions, states, continents or oceans.[105] Comparative history is said to be able to heighten contrasts and highlight experiences that are unique and hence bring new perspectives on the local, regional, and national histories.[106]

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[100] Patrick O'Brien, 'Historiographical Traditions and Modern Imperatives for the Restoration of Global History', *Journal of Global History* 1 (1), 2006, pp. 3-39.

[101] Ibid., pp. 38-39.

[102] Maxine Berg (ed.), *Writing the History of Global: Challenges for the Twenty-First Century* (Oxford: Oxford University Press, 2013).

[103] William H. McNeill, 'The Rise of the West after Twenty-Five Years', *Journal of World History* 1 (1), 1990, pp. 1-21; Id., *The Human Web: A Bird's-Eye View of World History* (New York: Norton, 2004); Id., 'Transatlantic History in World Perspective', in Steven G. Reinhardt and Dennis Reinhartz (eds.) *Transatlantic History* (Texas: University of Texas at Arlington, 2006), pp. 7-9.

[104] Id., 'Rise of the West', pp. 12-20.

[105] O'Brien, 'Historiographical Traditions', p. 5.

[106] William Sewell, 'March Bloch and the Logic of Comparative History', *History and Theory* 6 (2), 1967, pp. 208-18; Karën Wigen, 'Japanese Perspectives on the Time/Space of Early Modernity', in

My thesis follows in the tradition of global history and focuses on the global connections created through commodity trade and their effects on Bengal. It highlights the role of political economy in creating interdependencies. The focus of the thesis is on connections as connections with the British and Piedmontese silk industries importantly shaped Bengal silk production. However, the thesis also engages in international comparisons when it relates Bengal silk production to the Chinese and Italian silk industries and when it describes the technological level of the Bengal silk industry. Furthermore, in order to shed light on the key factors determining success of technology transfers, my thesis also compares the transfer of silk technologies to Bengal with the successful transfer of Western silk technologies to Japan in the nineteenth century.

My thesis draws on global history especially when it considers technology transfers. Technology has been one of the key agents shaping global history. New technologies transformed production techniques, shaped the systems of transportation and communication, as well as social, material and intellectual life.[107] Technology transfers and adaptations played a central role in the adoption and dissemination of technologies and thus also in economic and social development. Scholarship on early modern technology transfers has studied transfers within continents or transfers of Asian technologies to Europe.[108] The transfer of the Piedmontese silk technologies to

*Proceedings of the 19th International Congress of Historical Sciences* (Oslo: University of Oslo, 2000), pp. 26-27.

107 Dagmar Schäfer, 'Technology and Innovation in Global History and in the History of the Global', in Maxine Berg (ed.), *Writing the History of Global: Challenges for the Twenty-First Century* (Oxford: Oxford University Press, 2013), p. 147.

108 Technology transfers within Europe were studied for instance by: Liliane Hilaire-Pèrez and Catherine Verna, 'Dissemination of Technological Knowledge in the Middle Ages and the Early Modern Era: New Approaches and Methodological Issues', *Technology and Culture* 47 (3), 2006, pp. 536-65; Carlo Belfanti,'Guilds, Patents, and the Circulation of Technical Knowledge: Northern Italy during the Early Modern Age', *Technology and Culture* 45 (3), 2004, pp. 569-89. S. R. Epstein focused on the role of guilds in facilitating technology transfers and innovations in Europe. S. R. Epstein, 'Craft Guilds,

Bengal does not fit into either of these groupings. It is an example of a transfer of a more global character – the expertise originated in Italy but its transmission to Bengal was managed from London. Moreover, deindustrialization was not the result of this encounter with Europe. Last, this case illustrates that the populations in colonized areas often had more economic agency than the scholarship presumes.[109] The Bengal case clearly shows that the EEIC did not have enough power to coerce peasants and that the only way to achieve its economic goals, was to use market incentives.

## Sources and Methodology

My thesis draws from a variety of printed and manuscript sources at the British Library, Goldsmiths Library, the Library of the London School of Economics, and The National Archives. In particular, I use the EEIC records deposited at the India Record Office to analyse the steps undertaken by the Company in Bengal silk industry. Bengal Despatches – documents sent by the Court of Directors in London to the Board of Trade in Bengal (IOR/E/4) and the letters sent from Bengal to the Court in London (IOR/E/1) are key sources for this thesis. For the time period 1757-9, the records of the factory in Kasimbazar are an important source for understanding the procurement and trade of raw silk (IOR/G/23/3). Data on the silk trade comes mainly from the India Office Parliamentary Branch Records, especially the Reports from the Select Committee on the

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Apprenticeship, and Technological Change in Preindustrial Europe', *Journal of Economic History* 58 (3), 1998, pp. 648-713. For transfer of Asian technologies to Europe see for instance: Giorgio Riello, 'Asian Knowledge and the Development of Calico Printing in Europe in Seventeenth and Eighteenth Century', *Journal of Global History* 5 (1), 2010, pp. 1 and 6; Maxine Berg, 'Useful Knowledge, 'Industrial Enlightenment, and the Place of India', *Journal of Global History* 8 (1), 2013, pp. 117-36.

[109] Gareth Austin, 'The 'Reversal of Fortunes' Thesis and the Compression of History: Perspectives from African and Comparative Economic History, *Journal of International Development* 20 (8), 2008, pp. 998 and 1108-112.

Affairs of The East India Company which offers a wealth of information on silk (L/PARL/2/55).

Relying on the documents in the India Record Office is beneficial because of the number of documents by the Court of Directors in London sent to Bengal. The Court of Directors in London was the principal managerial body of the EEIC and its documents contain a wealth of information on the filature silk production and silk trade. Moreover, the IOR/E/4 and IOR/E/1 documents also contain reports from the Company's silk specialists. The importance of these documents is heightened by the fact that reports sent by EEIC's servants in India to London are not reliable.[110] Several members of the Board of Trade in Bengal – the principal administrative and managerial body of the EEIC in Bengal – misinformed the Court and overcharged the Company for the silk they procured and/or produced on behalf of the EEIC, thus they are misleading.[111] The potential limitations of the documents in the India Record Office is their narrow focus on the Company's filature silk production and lack of interest in information about silk production for local markets. However, since this thesis also focuses on the Company's activities, this should not have a negative impact. The documents might also be negatively biased against the Company's servants, and escpecially Bengalese reelers and peasants. However, the alleged cases of misconduct can often be supported by quantitative evidence – as in the case of fraud on the part of

[110] The Board of Trade in Bengal was often not supplying appropriate information about silk production. For instance, the Board was deliberately keeping information about the costs of filature silk production from the Court of Directors and in the 1770s-80s it was buying silk from private filatures on behalf of the EEIC for prices almost double the real production costs. IOR/E/4/630, 12 April 1786, pp. 390-91.

[111] Davini relies in much of his dissertation on reports from servant such as William Aldersey or Simeon Droz. See for instance, Davini. 'Una Conquista Incerta', pp. 234-58. However, Droz and Aldersey were among the members of the Board of Trade sued by the EEIC in the Court of Chancery for fraud concerning silk trade. TNA C 12/175/27, The National Archives (hereafter TNA), 24th March 1789 to 11th November 1789.

the Board of Trade. Furthermore, in order to lessen the EEIC bias, I use the Chancery Proceedings held by the National Archives when my research focuses on the principal-agent problems affecting the success of the filature silk production in Bengal.[112] These documents are a way to assess the trustworthiness of the information recorded by the Court of Directors.

My study of the political and economic environment of eighteenth-century Britain is based on analysis of contemporary treatises and pamphlets. A collection of such resources is held at the Goldsmiths Library, University of London, and the database 'Making of the Modern World' has enabled me to access items held by the Kress Library, Harvard. The most valuable information about the EEIC's silk production in Bengal can be found in the *Reports of the Committee of Warehouses of the East-India Company Relative to Extending the Trade on Bengal Raw-Silk*.[113] These reports were prepared by the EEIC and contain extensive data on the silk trade. Two of these reports are to be found at the Goldsmiths Library, while the third is in the Archives of the Royal Society of Arts. The most comprehensive report on the Company's silk production in Bengal is *Reports and Documents Connected with the Proceedings of the East-India Company in Regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* published by the EEIC in 1836.[114]

Similar limitations as in the case of the documents in the India Record Office apply also to the above mentioned documents. However, the reports contain especially quantitative data which should not have biases. Moreover, to gain a different perception

[112] TNA C 12/175/27, 24 March 1789 to 11 November 1789.

[113] Goldsmiths' Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*; Royal Sciety of Arts (hereafter RSA) RSA/SC/EL/2/31, *Third Report of the Committee of Warehouses of the East-India Company Relative to Extending the Trade on Bengal Raw-Silk* (London: n.p., 1795).

[114] LSE Archives, W7204, East India Company, *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London, J.L. Cox, 1836).

of the contemporary views on the Company's silk manufacturing activities, I rely on pamphlets – in particular on the *Considerations on the Attempt of the East-India Company to Become Manufacturers in Great Britain*.[115] The limitation of this source is its negative bias against the EEIC, however many of the arguments of the pamphlet are supported by either qualitative or quantitave evidence that it puts forward.

The next section discusses the main methodologies my dissertation relies on. The thesis draws mostly on economic and business history methodologies such as theories of quality, new institutional economics, value and commodity chains, knowledge transfers and factors that undermine the success of knowledge transfers as well as principal-agent problems, lack of adaptations, and incompatible factor endowments.

## Quality and Quality Enforcement

The quality of Bengal raw silk played a central role in the EEIC's efforts to substitute imports of Italian raw silk into Britain. The EEIC needed to improve the quality of raw silk and standardize it to enable full substitution. Quality improvement was a central concern of the Court of Directors. Issue of quality were also interlinked with knowledge transfer and principal-agent problems therefore quality is a key theme in the thesis. Quality is defined in the thesis in terms of relative quality or quality regulated by market demand, specifically the quality of raw silk demanded by the British market.[116] My

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[115] Goldsmiths' Library [G.L.], 1796 fol. 16654, *Considerations on the Attempt of the East-India Company to Become Manufacturers in Great Britain* (London: n.p., 1796).

[116] Giorgio Riello has explored the differences between the French and the English seventeenth- and eighteenth-century understanding of quality as something absolute versus the Asian understanding of quality as something based on fashion and innovation and judged by consumers rather than bureaucrats. Giorgio Riello, 'Governing Innovations: The Political Economy of Textiles in the Eighteenth Century', in Evelyn Welch, Fashioning the Early Modern (Oxford: Oxford University Press, 2016).

dissertation draws on the ‘quality of products’ debate.[117] Philippe Minard and William J. Ashworth explored the role of the French and English state in controlling quality of manufactures. Both authors underlined that for the state bureaucy there was only one very specific definition of quality that needed to be complied for by the manufacturers.[118] This dissertation presents a contrasting example in which the quality of manufacturing was not regulated by these state-imposed institutional frameworks. The way the EEIC understood quality was even more flexible than Philippe Minard’s ‘deliberated quality’ – quality defined collectively by a variety of stakeholders in a sector, as for instance the leather trades.[119]

The EEIC did not need to satisfy a standard of ‘absolute quality’ to succeed on the British market. The Court of Directors had no intention to regulate the quality of raw silk in the same way as the British government might have done. Their only aims were to produce silk close to Italian-quality and to avoid production of substandard silk – production of bales containing silk of different qualities. The Company did not have sufficient administrative power, unlike the French or British governments to impose a bureaucratic system of quality control on manufacturers of Bengal. The EEIC’s power was limited and the dissertation reveals the Company’s failure to even implement a system of quality enforcement in the factories under the Company’s direct control.

[117] Philippe Minard, Pierre Gervais and Judith Le Goff, ‘Colbertism Continued? The Inspectorate of Manufactures and Strategies of Exchange in Eighteenth-Century France’, *French Historical Studies* 23 (3), 2000, p. 479; William J. Ashworth, ‘Quality and the Roots of Manufacturing “Expertise” in Eighteenth-Century Britain’, *Osiris* 25 (1), 2010, pp. 238-44.

[118] The regulation of quality served also as a tool of protection against the items of foreign products. Ashworth, ‘Quality and the Roots of Manufacturing’, pp. 232-40.

[119] Philippe Minard, ‘Micro-Economics of Quality and Social Construction of the Market: Disputes among the London Leather Trades in the Eighteenth Century’, *Historical Social Research* 36 (4), 2011, pp. 150 and 160-61.

However, some similar approaches were used both by the British government and the EEIC as both relied on specialists for the expertise on quality.[120]

## Technology Transfer and Adaptations

The EEIC relied on the transfer of the Piedmontese system to improve the quality of Bengal silk. This system of reeling was based on the adoption of new machinery and a centralized system of production. The thesis evaluates the importance of centralization of production for making this technology transfer possible. My research follows Joel Mokyr's argument that shows that centralization of production is related to the cost of transferring information. Once the costs of transferring information and knowledge of production practices became higher than the costs of setting up centralized factories – factories prevailed over other methods of the organization of production. [121]

However the transmission of the Piedmontese system and the subsequent centralisation of production was not without problems. Most importantly the new system of reeling did not bring the expected improvement in quality. The thesis therefore uses different theoretical bodies to understand why this was the case. My research tests Nathan Rosenberg's hypothesis that paying attention to "special environments of individual countries" is central for the success of technology transfers.[122] I argue that the success of the technology transfer in Bengal was hampered by the fact that the EEIC disregarded the wider framework of the Piedmontese system of reeling. My research considers institutional failure, lack of adaptations and differing factor prices as possible explanations.

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[120] Ashworth has shown that the British government relied on the Board of Excise for knowledge about quality. Ashworth, 'Quality and the Roots of Manufacturing', pp. 231-32.

[121] Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton: Princeton University Press, 2002), pp. 120 and 141-45.

[122] Nathan Rosenberg, 'Economic Development and the Transfer of Technology: Some Historical Perspectives', *Technology and Culture* 11 (4), 1970, pp. 550-75.

There are several factors that can undermine the success of knowledge and technology transfers. Institutional adaptations aside, technical and commercial adaptations and the creation of backward and forward linkages have a key role. Technologies often have to undergo a series of adaptations – commercial, economic, technical, and institutional – before they can be efficiently used.[123] This thesis thus evaluates whether the Piedmontese system of reeling was adequately adapted to the socio-economic conditions of Bengal. This thesis draws on the work of Liliane Hilaire-Pèrez and Catherine Verna who have observed that "each technique was embedded in a material and immaterial environment: a set of resources and a web of skills, abilities, and representations".[124] Transferring this environment wholesale might prove to be impossible. What is crucial then according to Hilaire-Pèrez and Verna is for the adaptation to suit the needs and resources of the recipient region.[125] Adaptations have been studied in particular by Edwin Mansfield.[126] He has argued that firms which implemented commercial and economic in addition to technical adaptations were more successful.[127]

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[123] Edwin Mansfield, 'International Technology Transfer: Forms, Resource Requirements, and Policies', *American Economic Review* 65 (2), 1975, p. 373; Edwin Mansfield and Samuel Wagner, 'Organizational and Strategic Factors Associated with Probabilities of Success in Industrial R&D', *The Journal of Business* 48 (2), 1975, p. 187.

[124] Hilaire-Pèrez and Verna, 'Dissemination of Technological Knowledge', p. 544.

[125] Ibid., p. 557.

[126] Edwin Mansfield, 'International Technology Transfer: Forms, Resource Requirements, and Policies', *American Economic Review* 65 (2), 1975, pp. 372-76; David J. Teece, 'Technology and Technology Transfer: Mansfieldian Inspirations', *Journal of Technology Transfer* 30 (1/2), 2005, pp. 17-33; Edwin Mansfield and Anthony Romeo, 'Technology Transfer to Overseas Subsidiaries by U.S.-Based Firms', *The Quarterly Journal of Economics* 95 (4), 1980, pp. 737-50; Edwin Mansfield, 'Intellectual Property Protection, Direct Investment, and Technology Transfer: Germany, Japan and the United States', *IFC Discussion Paper* 27, 1995; Edwin Mansfield, 'The Speed and Cost of Industrial Innovation in Japan and the United States: External vs. Internal Technology', *Management Science* 34 (10), 1988, pp. 1157-168.

[127] Mansfield and Wagner, 'Organizational and Strategic Factors', p. 188.

My thesis also investigates whether the Company was able to create backward linkages to sericulture. Backward linkages denote opportunities for growth in industries/agricultural activities that are supplying inputs, such opportunities are created by growth in a sector that relies on these inputs. The growth in the downstream manufacturing activities creates positive externalities to the upstream manufacturer. Backward linkages are created by input-output relations of different production activities and are said to be an important source of competitive advantage especially for staple industries which rely on raw materials to create value added.[128]

## New Institutional Economics and Principal-Agent Problems

My thesis draws on new institutional economics, especially on the work of Oliver Williamson. Williamson focuses on how efficiency is achieved and transaction costs minimised through new ways of organising production.[129] Such an approach offers a way to study the institutional framework of filature production – systems of contracts, hierarchy and incentives – and assess its efficiency.

In Bengal, the inefficiency of the institutional framework of production was closely linked to principal-agent problems. The principal-agent problem denotes the dilemma of how to motivate an agent to act in the best interest of the principal. It arises from asymmetries of information or conflict between the interests of principals and

[128] Albert Hirschman, *The Strategy of Economic Development* (New Haven, London: Yale University Press, 1958); Albert Hirschman, 'A Generalized Linkage Approach to Development with Special Reference to Staples', in Albert Hirschman, *Essay in Trespassing, Economics to Politics and Beyond* (Cambridge: Cambridge University Press, 1981), p. 65.

[129] Oliver E. Williamson, 'The Organization of Work: A Comparative Institutional Assessment', *Journal of Economic Behaviour & Organization* 1 (1), 1980, pp. 5-38; Id., 'Transaction-Cost Economics: The Governance of Contractual Relations', *Journal of Law and Economics* 22 (2), 1979, pp. 233-61; Id., 'The Theory of the Firm as Governance Structure: From Choice to Contract', *Journal of Economic Perspectives* 16 (3), 2002, pp. 171-95; Id., 'The Vertical Integration of Production: Market Failure Considerations', *The American Economic Review* 61 (2), 1971, pp. 112-23.

agents.[130] The Company relied on a number of agents when contracting for silk: peasants, silk reelers, dadni merchants and its own servants. Sericulture was carried out by peasants while the role of merchants and entrepreneurs was limited to the procurement of cocoons.[131] The Company thus relied on intermediaries who were given a dadni (advance payment) in return for the promise to deliver cocoons of a specified quality.[132] Peasants owned their product throughout the production process which was a significant difference to the putting-out system practiced in Europe and it gave the artisans more freedom.[133] For the Company, however, it meant that many silk producers did not abide to the contracts.[134] The Company encountered principal-agent problems with its workers in filatures as they were native reelers and servants. The central problem was that the geographical distance exacerbated the asymmetry of information between the principal (the Court of Directors in London) and the agents (the Board of Trade in Bengal).

There are several possible solutions to principal-agent problems. Key to it is contract enforcement. In the pre-modern period contracts were enforced through informal as well as institutional arrangements. Both of these systems must be self-enforcing and need to minimise the possibility of shirking. Avner Greif analysed the systems of contract enforcement practiced by Maghribi and Genovese traders in the

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[130] See Sanford J. Grossman and Oliver D. Hart, 'An Analysis of the Principal-Agent Problem', *Econometrica* 51 (1), 1983, pp. 7-46.; Ray Rees, 'The Theory of Principal and Agent, Part I', *Bulletin of Economic Research* 37 (1), 1985, pp. 3-26.

[131] Davini, 'History of Bengali Raw Silk', p. 8.

[132] Ibid., p. 3. The dadni system was explored for instance by: Sushil Chaudhuri, 'Merchants, Companies and Rulers: Bengal in the Eighteenth Century', *Journal of the Economic and Social History of the Orient* 31 (1), 1998, p. 76-77; Mukherjee, 'Story of Kasimbazar', pp. 500-20.

[133] Bishnupriya Gupta, 'Competition and Control in the Market for Textiles: Indian Silk Weavers and the English East India Company in the Eighteenth Century', in Riello and Roy (eds.), *How India Clothed the World*, p. 292.

[134] Ibid., pp. 292-93.

eleventh to thirteenth centuries. Maghribi traders relied on an informal system of multilateral collective punishment – a system of contracts based on reputation, and in which enforcement relied on personal relationships between traders and sharing of information about fraudulent behaviour. In contrast, Genoese traders relied instead on a system of formal third party enforcement of contracts in which the parties in a contractual relationship relied on the state for enforcement.[135] The EEIC, however, encountered the problem in an early supply phase of production.

The EEIC's contractual relations with producers were prone to principal-agent problems due to freedom of contract and the absence of a formal system of contract enforcement. The Company attempted to mitigate the problem through vertical integration. It established silk filatures in which it owned the fixed capital as well as the inputs necessary for production and hired former producers as employees.[136] Despite several drawbacks, the costs of supervision and the challenge of recruiting workers among part-time agriculturalists, vertical integration enabled the EEIC to introduce measures to raise the quality of the reeled silk. However, the EEIC did not pay sufficient attention to the agency problems associated with vertical integration, which undermined the success of the measures to raise quality. Rachel E. Kranton and Anand V. Swamy point to the fact that vertical integration creates new types of agency problems related to the need for supervision.[137] This occurred in filature production in Bengal. In my analysis of the principal-agent problems of filature production I rely on the work by Williamson who emphasised that without private ordering and the creation

[135]Avner Greif, 'The Fundamental Problem of Exchange: A Research Agenda in Historical Institutional Analysis', *European Review of Economic History* 4 (3), 2000, p. 278.

[136] Rachel E. Kranton and Anand V. Swamy, 'Contracts, Hold-up, and Exports: Textiles and Opium in Colonial India', *American Economic Review* 98 (3), 2008, p. 980.

[137] Ibid., pp. 967-89.

of incentives and contracts within firms, vertical integration cannot bring the expected benefits.[138]

**Factor Prices and Commodity and Value Chains**

Factor prices are a further element often considered decisive for the success of knowledge transfers. Different development and technological paths are often explained by differing factor prices.[139] Yurio Hayami and V. W. Rutan argue that the likeness of factor prices in the country where a technology originates and the country where it is imported is crucial for the economic viability of its use.[140] Only a technology which uses a factor that is abundant while saving the factor that is scarce can be sustainable in the long-term.[141] However, the question of suitability of different systems of organization of production in a specific industry can also be perceived from the point of view of commodity and value chain theory.

[138] Williamson, 'The Theory of the Firm', p. 172.

[139] Stephen Broadberry and Bishnuprya Gupta, 'Lancashire, India, and Shifting Competitive Advantage in Cotton Textiles, 1700-1850: The Neglected Role of Factor Prices', *Economic History Review* 62 (2), 2009, pp. 279-305; E. Rothbarth 'Causes of the Superior Efficiency of USA Industry as Compared with British Industry', *Economic Journal* 56 (223), 1946, pp. 383–90; Robert Allen, *The British Industrial Revolution in Global Perspective* (Cambridge: Cambridge University Press, 2009); Robert Allen, Jean-Pascal Bassino, Debin Ma, Christine Moll-Murata, Jan Luiten van Zanden, 'Wages, Prices, and Living Standards in China, 1738–1925: In Comparison with Europe, Japan, and India', *Economic History Review,* 64 (S1), 2011, pp. 8–38; Robert Allen, 'The High Wage Economy and the Industrial Revolution: A Restatement', *Economic History Review* 68 (1), 2015, pp. 1-22.

[140] Yurio Hayami and Vernon W. Rutan, 'Factor Prices and Technical Change in Agricultural Development: The United States and Japan, 1880-1960', *Journal of Political Economy* 78 (5), 1970, pp. 1115-141.

[141] See H. J. Habakuk, *American and British Technology in the Nineteenth Century: The Search for Labour-saving Inventions* (Cambridge: Cambridge University Press, 1967); William Fellner, 'Two Propositions in the Theory of Induced Innovations', *Economic Journal* 71 (282), 1961, pp. 305-8.

A substantial body of literature considers changes within commodity and value chains to be key to shaping technology paths.[142] My dissertation relies particularly on Michael E. Porter's value chain theory but also on development studies literature that argues in favour of the adoption of new technologies in spite of their high initial costs.[143] The concept of commodity chain – "a network of labor and production processes whose end result is a finished commodity" is a useful way to approach silk production in the early modern period.[144] A value chain – a "collection of discrete activities performed to do business in [its] industry" – is then a valuable framework for studying the EEIC's involvement in Bengal raw silk production.[145] It builds on a disaggregated view of a firm – according to this theory, the firm coincides with the value chain. My thesis calculates the returns of investment in silk filature production as the success of different technologies and systems of organization of labour is

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142 Terrence Hopkins and Immanuel Wallerstein, 'Conclusions about Commodity Chains', in Gary Gereffi and Miguel Korzeniewicz (eds.), *Commodity Chains and Global Capitalism* (Westport: Praeger, 1994), p. 48; Eyüp Özveren, 'The Shipbuilding Commodity Chain, 1590-1790', in Gereffi and Korzeniewicz (eds.), *Commodity Chains and Global Capitalism*, pp. 20-34; Jennifer Bair and Gary Gereffi, 'Local Clusters in Global Chains: the Causes and Consequences of Export Dynamism in Torreon's Blue Jeans Industry', *World Development* 29 (11), 2001, pp. 1885-1903; Jeff Neilson and Bill Pritchard, *Value Chains: Institutions and Governance in the Plantation Districts of South India* (London: John Wiley & Sons, 2011); Gary Gerrefi, 'International Trade and Industrial Upgrading in the Apparel Commodity Chain', *Journal of International Economics* 48 (1), 1999, pp. 37-70.

143 Michael E. Porter, *Competition in Global Industries* (Boston: Harvard University Press, 1986), pp. 20-22; Id., 'Changing Patterns of International Competition', *California Management Review*, 28 (2), 1986, pp. 9-40; Id., *The Competitive Advantage of Nations* (New York: Free Press, 1990), pp. 41-51; The development literature often draws on the work by: Alexander Gerschenkron, *Economic Backwardness in Historical Perspective: A Book of Essays* (Boston, Massachussets: Harvard University Press, 1962). See also: Reinert, *Why Rich Countries Got Rich*; Chang, *Kicking Away the Ladder*; Lin and Chang, 'Should Industrial Policy in Developing Countries Conform', pp. 482-502.

144 Terence K. Hopkins and Immanuel Wallerstein, 'Commodity Chains in the World-Economy Prior to 1800', *Review Fernand Braudel Center* 10 (1), 1986, p. 159.

145 Michael E. Porter, Changing Patterns of International Competition, in David J. Teece (ed.), *The Competitive Challenge: Strategies for Industrial Innovation and Renewal* (Cambridge, MA: Ballinger, 1987), p. 13.

determined by their profitability. Only in this way can the thesis evaluate whether the EEIC derived benefits from the adoption of the Piedmontese system. The returns to investment analysis reveals whether the integration of silk reeling into the Company's value chain brought profits or whether the difference between factor prices in Piedmont and Bengal undercut the profitability of the project.

## Structure of the Thesis

Chapter 1 analyses the process of the production of raw silk, sericulture and silk reeling prior to the to EEIC's direct involvement in the Bengal silk industry. It examines knowledge of the 'best practices' for sericulture and silk reeling in Bengal and compares them to Italy and China, the world leaders in raw silk production in the eighteenth century. The chapter evaluates whether systems of raw silk production and procurement in Bengal had a negative impact on the quantity and quality of raw silk the Company was able to procure. Thus the chapter concludes that the methods of sericulture and silk reeling were at the heart of the production of coarse silk unequal in skeins and that the EEIC was unable to enforce the adoption of new practices under the existing putting-out system.

Chapter 2 explores the factors that underpinned the Company's perception that Bengal raw silk was an item worthy of investment and thus convinced the Company to become a silk manufacturer in Bengal. The chapter examines the extent to which changes to the EEIC's finance in the aftermath of the Battle of Plassey (1759) and the British government's support of the domestic silk industry led the Company to make this decision. The Battle of Plassey gave the Company access to the tax revenues of Bengal, Bihar and Orissa. However the Company needed to transfer them to Britain and the export trade proved to be the best channel. The chapter concludes that several factors – cost of freight, import duties, demand for raw silk on the British market and the role of raw silk in the intra-Asian trade – created the idea that Bengal raw silk was one of the 'choicest' goods. The chapter also considers the influence of the contemporary British political economy on the Company's actions.

Chapter 3 examines the steps taken by the Company to improve the quality of Bengal raw silk. The chapter studies the transfer of Piedmontese silk technologies to Bengal, one of the main measures in the EEIC's plan to substitute Bengal raw silk for imports of other raw silks to the British market. I consider the technical issues accompanying the setting up of silk filatures in Bengal, and the technologies and equipment imported from Europe. I explore the changes to the organization of labour and the role that Italian silk specialists had in setting up silk filatures, implementing and supervising the new method of reeling, and in training the labour force in Bengal. The chapter highlights the lack of attention to incentivising the Company's servants and reelers to focus on quality of production, the consequence was that it undermined quality improvement despite the adoption of the new technologies.

Chapter 4 analyses the development of the EEIC's trade in Bengal raw silk from the 1750s to 1812. It evaluates how successful the Company's plan to substitute Bengal raw silk for raw silk from other regions really was. The chapter considers the demand for raw silk on the British market. It also considers the Company's plan to throw Bengal raw silk into organzine in Britain in an attempt to expand its use in the British Isles. The chapter concludes that in spite of an increase in the market share after the adoption of the Piedmontese system of reeling, significant quantities of Bengal raw silk remained unsold because their quality was too low.

Chapter 5 considers silk production of Bengal after the implementation of the Piedmontese system. The chapter draws on factor-price theory and investigates whether the Piedmontese reeling system fit Bengal's factor-supply conditions. The chapter analyses the costs of production of filature silk in Bengal and compares them to Piedmont. It shows that the adoption of the factory system was not incompatible with the existing factor endowments of Bengal. The costs of producing silk in filatures were lower than the costs of procuring it from intermediate merchants. Furthermore, returns to investment analysis shows that the investment into the filature system was highly profitable. The chapter relies on commodity chain and value chain theory to interpret these findings.

Chapters 6 and 7 consider the factors that undermined the success of the EEIC's investment in raw silk manufacturing in Bengal. Despite of the overall profitability of the investment, the venture was riddled with problems. The major problem was the production of low or non-standard quality silk – silk bales with high-quality silk on the top and low quality throughout the bale – in several of the filatures.

Chapter 6 considers the factors that were behind the production of low and/or substandard quality silk from the point of view of institutions. It studies the effects of the institutional framework of silk production on the success of the filature system. The chapter approaches institutions from the point of view of organisational theory and focuses on contracts and the incentives of agents. The chapter argues that the institutional framework in Bengal facilitated principal-agent problems and fraud, and ultimately thus led to the creation of 'market for lemons' – a situation when good quality and substandard quality products are sold in the market and the buyer has no chance to differentiate these goods. These issues undermined the demand for and price of Bengal raw silk. Hence, the EEIC's venture into Bengal silk production can be seen as an institutional failure.

Chapter 7 considers commercial and economic, social and technical adaptations of the Piedmontese system to the environment in Bengal. The chapter highlights the unequal focus on technical adaptations, although it points out that commercial and economic, and social adaptations were not completely neglected. The chapter also examines adaptations in sericulture and explores the factors that hampered the possibility of implementing changes to the practices of sericulture.

The thesis concludes with a reflection on the role of silk industry in early modern economies and the connection between technology transfers and economic development. The conclusion reiterates the argument that adaptations are the key to success of technology transfers and that adaptation of institutional framework of production should not be omitted.

# CHAPTER 1

## The Bengal Silk Industry before the English East India Company

> This silks are not certainly so fine as those of Persia, Syria, Sayd, Bairut, but they are of a much lower price, and I know from indisputable authority that if they were well selected and wrought with care, they might be manufactured into most beautiful stuffs.[1]

So Bernier commented upon the silk production of Mughal India in the late seventeenth century. The methods of silk production used in India were not at the forefront of technological innovations. However, Bernier's view indicates also the potential ascribed to Indian silk production by Europeans. This chapter explores the methods of sericulture and silk reeling used in Bengal before the EEIC started to be directly involved in the region's silk industry. The chapter compares this method with those methods used in the Italian and Chinese silk industries. Finally, it analyses the organization of production of the Bengal silk industry and the methods of procurement of Bengal raw silk.

### 1.1. Views on Indian Silk Production

India and China constituted the main world industrial areas of the pre-modern times.[2] India attained a pre-eminent position particularly in cotton textile production, a sector in which the subcontinent developed superior knowledge and exceptional productive

[1] Francis Bernier, *Travels in the Mogul Empire* (London: W. Pickering, 1826), Vol. 1, p. 439.

[2] Maxine Berg, 'Useful Knowledge, 'Industrial Enlightenment', and the Place of India', *Journal of Global History* 8 (1), 2013, p. 117.

skills.[3] This chapter asks whether superior knowledge of production processes characterised also raw silk production. Should the phrase 'textile factory of the world' include India's silk industry in the eighteenth century?

Indian cotton production was exported to other regions in Asia, Africa, as well as the Americas and Europe, fostering long-distance trade and conquering global markets. The distinctive aesthetic qualities, designs, and colours created strong international demand for Indian cottons. India's pre-eminent position in the production of cotton textiles in the pre-modern period was underpinned by superior knowledge of dyeing and printing and the precision of its weavers and other textile artisans.[4] However, the success of the cotton industry was achieved mainly thanks to the high-quality of the Indian finishing processes.[5] In the case of cotton textiles, India's 'comparative advantage' rested upon knowledge which stemmed from long-term familiarity with production techniques and practices by Indian artisans.[6]

As this chapter shows, superior knowledge and/or sophisticated production technologies did not characterize the Bengal silk industry. Some contemporary travelogues create a misleading impression that Bengal was a region renowned for the production of silks suitable for European markets, often confusing the demand for

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[3] See Giorgio Riello and Tirthankar Roy (eds.), *How India Clothed the World* (Leiden and Boston: Brill, 2009); Prasannan Parthasarathi, 'Cotton Textiles in the Indian Subcontinent, 1200-1800', in Giorgio Riello and Prasannan Parthasarathi (eds.), The *Spinning World: A Global History of Cotton Textiles, 1200-1800* (Oxford: Oxford University Press, 2009), pp. 17-41.

[4] Giorgio Riello, 'Asian Knowledge and the Development of Calico Printing in Europe in Seventeenth and Eighteenth Century', *Journal of Global History* 5 (1), 2010, pp. 1 and 6; Parthasarathi,'Cotton Textiles', pp. 18-21.

[5] Giorgio Riello, *Cotton: The Fabric that Made the Modern World* (Cambridge: Cambridge University Press, 2013), p. 83.

[6] Ibid., p. 362. In particular, it was the knowledge of the finishing processes that rendered Indian cotton textiles a highly sought after item on the global market. Riello, *Cotton*, p. 80.

finished and raw silk.[7] Moreover, the story of raw silk production needs to be disentangled from that of silk weaving, even if these two stages of production are intimately related. Prior to the standardization of the nineteenth century, silk was not a homogeneous product and woven silks from different countries or using different methods of production could be easily distinguished.[8] Giovanni Federico contends that the specific production methods resulted in specific physical characteristics, which made a "certain type of silk comparatively more suited for producing a specific type of silkware and/or for being processed with some type of equipment".[9] The types of silk products demanded by European and Indian consumers differed, therefore different qualities of raw silk were needed. Eighteenth-century Indian consumers valued silk fabrics for the reputation of the place of weaving or for their colours. In contrast, Europeans demanded high-quality silk fabrics with fashionable designs.[10] Europeans

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[7] Bengal was the only centre of commercial production of raw silk in seventeenth- and eighteenth-century India. The main silk production area was the region of Kasimbazar. When the European trading companies arrived in India, the trade in Kasimbazar silk was already well developed and its silk was traded within the Mughal Empire and across Asia. The Dutch East India Company was the first among the trading companies to import raw silk to Europe. However, to improve the quality of Bengal raw silk, over 80% of the imported silk had to be reeled under the Company's control in its reeling workshop. Irfan Habib, *The Agrarian System of Mughal India 1556-1707* (New Delhi: Asia Publishing House, 1963), p. 57; Om Prakash, *The Dutch East India Company and the Economy of Bengal, 1630-1720* (Princeton: Princeton University Press, 1985), pp. 55-7 and 219; Roberto Davini, 'Una Conquista Incerta. La Compagnia Inglese delle Indie e la Seta del Bengala,1769-1833' (Unpublished PhD thesis: European University Institute, 2004), p. 15.

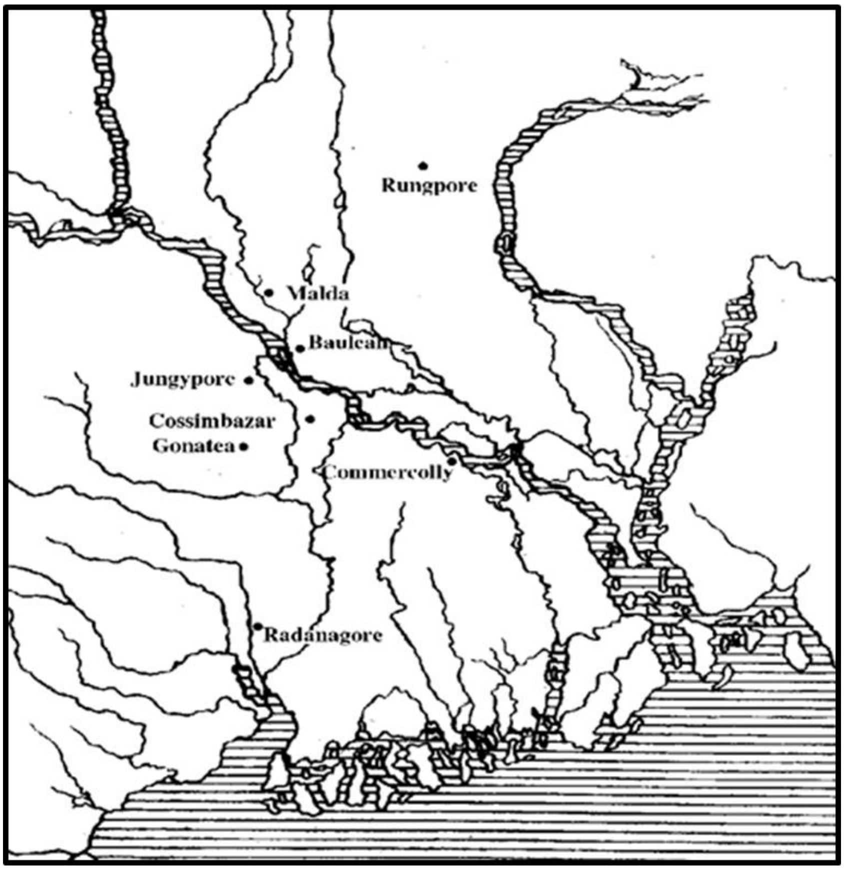
[8] Giovanni, Federico, *An Economic History of Silk Industry, 1830-1930* (Cambridge: Cambridge University Press, 1997), p. 53.

[9] Ibid.

[10] C.A. Bayly, 'The Origins of Swadeshi (Home Industry): Cloth and Indian Society 1700-1930', in Arjun Appadurai (ed.), *The Social Life of Things. Commodities in Cultural Perspective* (Cambridge: Cambridge University Press, 1986), p. 286; Roberto Davini, 'A Global Supremacy: The Worldwide Hegemony of the Piedmontese Reeling Technologies, 1720s-1830s', in Anna Guagnini and Luca Molà (eds.), *History of Technology, Vol. 32* (London: Bloomsbury Publishing, 2014), p. 99; Debin Ma, 'The Great Silk Exchange: How the World was Connected and Developed', in Debin Ma (ed.), *Textiles in the Pacific,*

also valued lightness and a uniformity of texture, qualities which could only be achieved if high-quality raw material inputs were used. This in turn required advanced reeling technology and high-quality cocoons.

**Figure 1.1. Map of the Principal Silk Producing Region in Bengal**




Source: Adapted from Roberto Davini, 'Una Conquista Incerta. La Compagnia Inglese delle Indie e la Seta del Bengala,1769-1833' (Unpublished PhD thesis: European University Institute, 2004), p. 221.

Positive views of the Indian silk industry relate to the superior quality of the finished silk fabrics, not raw silk. Brenda M. King, for instance, claims that "the silk textiles of India were and still are, some of the most widely admired and skilfully

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*1500-1900*. *The Pacific World: Lands, Peoples and History of the Pacific, 1500-1900* (Aldershot: Variorum, 2005), pp. 24 and 26.

produced in the world".[11] This view of Indian silks can be traced back to pre-modern sources. Travel accounts by Europeans show a certain degree of admiration for Indian silken products. The seventeenth-century French traveller François Bernier, for example, observed that in Bengal there were "such a quantity of cotton and silks that the Kingdom may be called the common storehouse for the two kinds of merchandise, not of Hindustan or the Empire of the Great Mughal only, but of all the neighbouring kingdoms, and even of Europe".[12] This and other positive views are, however, in stark contrast to the situation the EEIC encountered when exporting raw silk. Bengal raw silk was repeatedly described as inadequate quality material by the British silk manufacturers and weavers. Such raw silk was criticized for its coarseness and for its inequality that allowed it to be used only in the production of haberdashery.[13]

Mulberry silk culture was only introduced to India in the fifteenth century. Three hundred years later Indian production methods lagged behind other world areas, particularly China, Italy and France, the leaders in silk manufacturing.[14] There was no

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[11] Brenda M. King mostly focuses on the weaving skills of the Indian artisans and on the finishing processes that enabled the production of high-quality silk fabrics. She does not address the issue of the raw materials used for the production of such silk products. The use of imported raw silk of finer quality might reconcile the evidence on the production of low-quality silk thread and high-quality silks being weaved in India. Brenda M. King, *Silk and Empire: Studies in Imperialism* (Manchester: Manchester University Press, 2005), pp. 55-56.

[12] Bernier, *Travels in the Mogul Empire*, p. 439. Jean-Baptiste Tavernier also shows admiration for Indian silks. Jean-Baptiste Tavernier, *Travels in India* (London: Macmillan & Co, 1889), Vol. 2, pp. 2-4.

[13] All the contemporary materials called the silk "unequal in skeins", meaning that the skeins contained silk threads of different colour and made of different number of filaments. Goldsmiths´ Library [G.L.], 1796 fol. 16654, *Considerations on the Attempt of the East-India Company to Become Manufacturers in Great Britain* (London: n.p., 1796), p. 21; Goldsmiths´ Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London: n.p., 1795), pp. 13; K. N. Chaudhuri, *The Trading World of Asia and the English East India Company, 1660-1760* (Cambridge: Cambridge University Press, 1978), p. 346.

[14] Sanjay Shinha, *The Development of Indian Silk Industry: A Wealth of Opportunities* (London: Intermediate Technology Publications, 1990), pp. 4-5. For the origins of sericulture in India see: Lotika

apparent pressure from the domestic weaving sector to upgrade the available technologies. The rest of this chapter therefore addresses the question of why Bengal raw silk was of a quality lower than the Chinese and Italian silk and why the EEIC considered it feasible to increase the quality of raw silk by altering production methods.

## 1.2. Process of Production of Bengal Raw Silk

The reports and letters of silk specialists employed by the EEIC contain a wealth of information about the methods employed to produce silk thread in Bengal. Their reports for London frequently referred to the inefficiency of sericultural and silk reeling practices used in Bengal. None of these processes were close to the methods practiced in Italy or China.

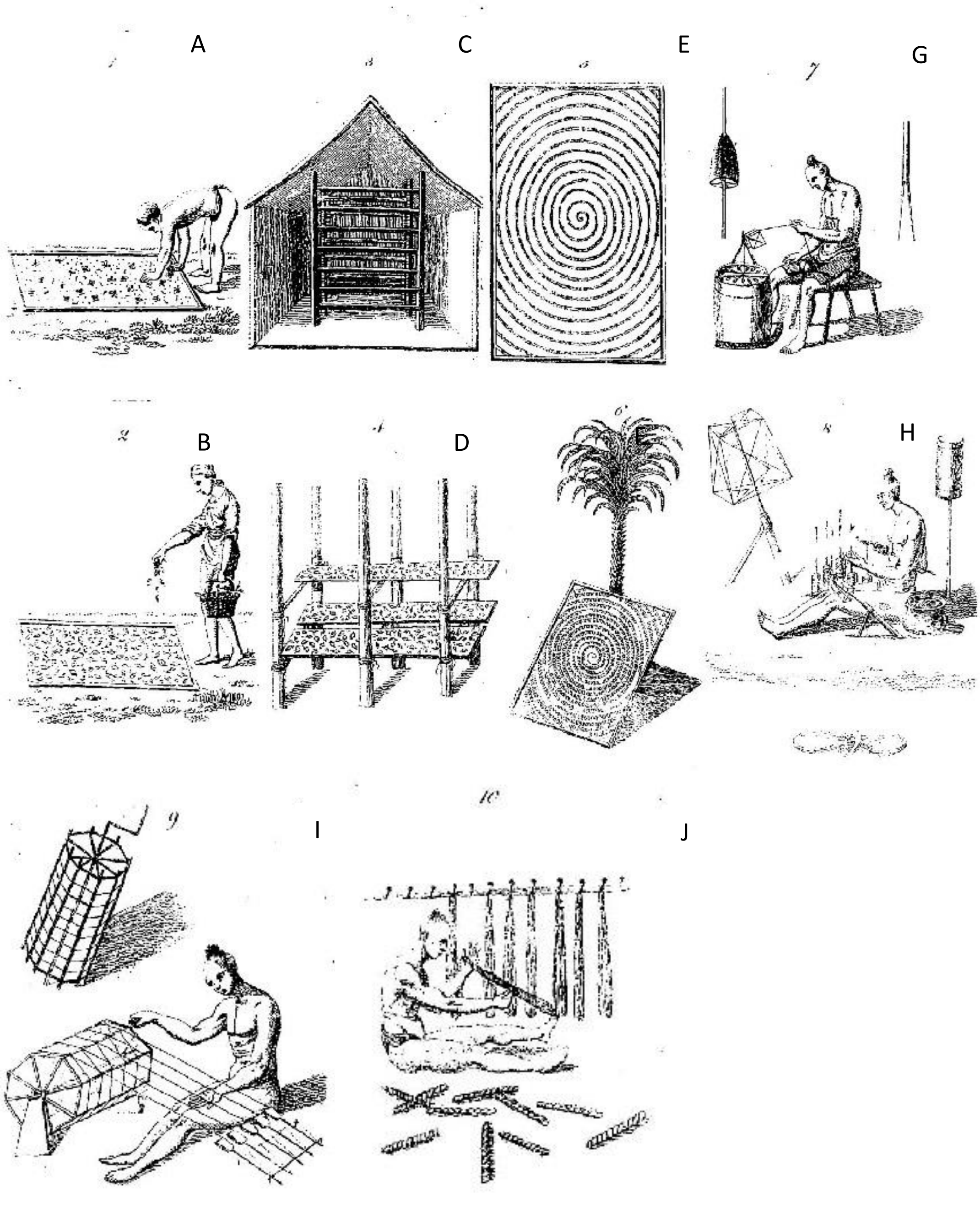
George Williamson – a former employee of the EEIC – wrote one of the best descriptions of the methods used in the production of raw silk in Bengal. A plate of drawings accompanied his descriptions of the rearing and feeding the worms and of the reeling and winding the silk in 1775 (Figure 1.2).

According to George Williamson's account, the moths were placed on a mat to mate so that the females would lay their eggs on this mat (figure 1.2A). When buds appeared on the mulberry shrubs, the silkworm eggs were exposed to enough sunlight to make them hatch. The worms were given food the morning after hatching in order to ascertain which were the healthiest. Those worms that were able to climb onto the leaves given to them were transferred onto mats and fed with mulberry leaves (figure 1.2B). During the rearing of the worms, the mats were stored on trays (figure 1.2D) that were kept in special buildings (figure 1.2C). When the worms were ready to spin their

Varadajan, 'Silk in Northeastern and Eastern India: The Indigenous Tradition', *Modern Asian Studies* 22 (3), 1988, pp. 565-70.

cocoons, they were moved onto a different mat which had a spiral of bamboo for the worms to fasten their thread (figure 1.2E).

**Figure 1.2. Plate Depicting the Practices of Sericulture and Silk Reeling in Bengal in 1775**




*Source:* Goldsmiths' Library [G.L.], 1775 fol.: George Williamson, *Proposals Humbly Submitted to the Consideration of Court of Directors for Affair of the United Company of Merchants of England Trading to the East Indies: For Improving and Increasing the Manufacture of Silk in Bengal* (London, s.n., 1775), pp. 17-18

The Indian method of killing the moth inside the cocoon was considered by Europeans to be detrimental to the quality of the raw silk. In Italy the normal practice was to kill the chrysalis inside the cocoon (before it could conclude its metamorphosis) in an oven or through the use of steam [at temperature of 70° or 80°C].[15] In India the moths were killed by exposing the cocoon to the rays of sunlight (figure 1.2F).[16] However, this method was unreliable because the cocoons could only be exposed to sun after all the cocoons were spun. Some silkworms spun their cocoon faster some slower, thus some had already started the metamorphosis into a moth at the time when the cocoons were exposed to sun. If the chrysalis was not killed inside the cocoon, the moth tore the cocoon while getting out. This lowered the quality of the silk and could render the cocoon unsuitable for further use.[17]

The last four scenes of Figure 1.2 depict the 'country' method of reeling and the processes of re-reeling the 'country-wound' silk. The silk was either reeled in the peasant households or by cuttanies, reelers who travelled from village to village.[18] A cuttany using reels and a split bamboo for reeling cocoons is depicted on figure 1.2G. Silk reeled using this method was known as 'country-wound' or 'Putney' and was deemed to be low quality as silk filaments of different lengths and fineness were reeled

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[15] Richard Hills, 'From Cocoon to Cloth: The Technology of Silk Production', in Simonetta Cavaciocchi (ed.), *La Seta in Europa Secc. XIII-XX* (Prato: Istituto Internazionale di Storia Economica, 1993), p. 63.

[16] Figure 6 shows the mat on which the worms were kept before being exposed to the sun.

[17] Hills, 'From Cocoon to Cloth', p. 63.

[18] Cuttanies had a reputation for not paying attention to quality: "the cuttanies who manufacture the Putney are dispersed all over the country neither under control or inspection; that they have no interest in the quality or sale of the silk nor any consideration beyond their daily pay which they receive from the chassars who rears the worm". WBSA, BoT Prcds 23 June 1778, 'Observations on Raw Silk and Remarks on these Observations', as cited in Davini, Una Conquista Incerta, p. 127; Id., 'The History of Bengali Raw Silk as Interplay between the Company Bahadur, the Bengali Local Economy and Society, and the Universal Italian Model, c.1750 – c.1830', *Commodities of Empire Working Paper* 6 (2008), p. 8.

together.[19] A further problem was inequality within the skeins as some contained single, double, triple or even quadruple parts.[20] Finally, it was often observed that much of the final silk was dirty or unfit for use.[21]

Country-wound silk did not have a market in Europe so the EEIC had to have the silk rewound before sending it to Britain. The country-wound silk was delivered to merchant agents and rewound by winders called nacauds.[22] The process of rewinding is depicted on figures 1.2H, 1.2I, and 1.2J. First, threads of different fineness had to be separated from each other using a reel and bobbin (figure 1.2H); then silk threads of different colours were separated by reeling the thread from the bobbin onto large reel (figure 1.2I), after this the reel was placed in the sun for the thread to dry. Only then was the silk twisted into skeins (figure 1.2J). [23]

## 1.3. Global Comparisons with Indian Sericultural and Silk Reeling Practices

The EEIC felt that it was necessary to improve the quality of Bengal raw silk by adopting new technologies if such silk was deemed to compete with higher quality raw

[19] Chaudhuri, *Trading World of Asia*, p. 346. However, it would be a mistake to suppose that filaments of different fineness and length were reeled into one skein only in Bengal. It seems that these problems were connected with household reeling in general especially in regions where incentives for high-quality silk production were wanting. For instance, low-quality raw silk was reeled also by households in Provence, France. See: Archives Nationales, Paris: Serie F12, F12 677A.

[20] India Office Records, British Library (hereafter IOR), IOR/E/4/616: ‘Bengal Raw Silk to be Investigated by Richard Wilder, 25 March 1757’, India Office Records and Private Papers, p. 557. Inequality in skeins arises when threads of different quality or threads consisting of different number of filaments are twisted together.

[21] IOR, Bombay (Misc. Public Documents, etc.)., 1793.m.17: ‘Letter from Giuseppe Mutti’, p. 7.

[22] Davini. ‘History of Bengali Raw Silk’, p. 8.

[23] Goldsmiths’ Library [G.L.], 1775 fol.: George Williamson, *Proposals Humbly Submitted to the Consideration of Court of Directors for Affair of the United Company of Merchants of England Trading to the East Indies: For Improving and Increasing the Manufacture of Silk in Bengal* (London, s.n., 1775), p. 16.

silk from Italy, China, Turkey, Persia, and Spain on European markets. There most demanded were Chinese and Italian varieties which were the best quality raw silks on the market. The quality of the Chinese and Italian raw silk was underpinned by the technological leadership in sericulture and silk reeling of both areas. In both regions existed incentives for the production of high-quality raw silk and the production of high-quality silk thread was further supported by state and guild regulation and by systems of taxation. China and Italy both relied on silk production for tax revenues, therefore their governments promoted the production of high-quality and high-value silk. Chinese sericulture and silk reeling practices differed markedly from Italian methods. Whereas, the Italian silk industry achieved its pre-eminence through a stringent organisation of production and the presence of institutions aimed at enforcing quality, this was not the case in China.

China retained technological leadership in silk production until the nineteenth century.[24] The empire benefitted from its long-term familiarity with the production techniques of raw silk. It can be argued that these benefits were similar to those that gave India a competitive advantage in the production of cottons. As in the Indian cotton industry, the knowledge of Chinese artisans and peasants of the production process was key factor in production of high-quality silk threads and fabrics. However, the Chinese silk industry did not rely on the inter-generational diffusion of tacit knowledge as 'best practices' were repeatedly codified. Gaines K. C. Liu has argued that in the silk industry through codification "the Chinese have developed a set of nomenclature which is definite and specific as in any modern science".[25] Codification of knowledge ensured

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[24] Peng Hao, 'Sericulture and Silk Weaving from Antiquity to the Zhou Dynasty', in Dieter Kuhn (ed.), *Chinese Silks* (New York: Yale University Press, 2012), p. 66.

[25] Gaines K. C. Liu, 'The Silkworm and Chinese Culture', *Osiris* 10, 1952, p. 165. Knowledge was codified in several treatises. The most important among these treatises are the *fu* on silkworm by Sun

that the processes of sericulture and silk reeling were carried out with great precision and therefore enabled the production of high-quality cocoons and silk thread.[26] China set best practices in sericulture in the early modern period and was also a global leader in the development of silk reeling technologies. The Chinese reeling methods were the most technologically advanced until the Piedmontese revolution in the seventeenth century.[27]

The Chinese relied on longstanding experience and capacity to innovate production methods. Peasants also had several incentives to produce high-quality silk thread. First, silk was an important item of tax payment revenues during the Empire's history.[28] Second, China had a flourishing domestic commercial market for silk, which was highly profitable as high-quality silk fetched high prices, thus peasants were given incentives to improve the quality of their production. [29]

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Ching, the *Tsan Ching* by Liu An, the *Chi Ming Yao Shu* by Chia Sheh, the *Tsan Sa* by Ch´in Kuan, the *Keng Chi Tu* by Lou Shou, the *Nung Sang Chi Yao* by the Ministry of Agriculture of the Yuan Dynasty and the *Tsan Sang Hoh Pien* by Wan Chi. Liu, 'Silkworm and Chinese Culture', p. 185.

[26] Liu,'Silkworm and Chinese Culture', p. 177.

[27] Among the most significant inventions was a reeling frame adopted in the Song period (960-1127). This frame allowed the Chinese to produce a silk thread thinner and finer than anywhere else in the world. Claudio Zanier, 'Pre-Modern European Silk Technology and East Asia: Who Imported What?', in Ma (ed.), *Textiles in the Pacific,* p. 144.

[28] Dieter Kuhn, 'Textile Technology: Spinning and Reeling', in Joseph Needham (ed.), *Science and Civilization in China: Chemistry and Chemical Technology* (Cambridge: Cambridge University Press, 1988), Vol. 5, Part 9, pp. 285-89. Silk was the most important Chinese export item in the pre-modern period and the Ming Dynasty (1368-1644) promoted silk production through a tax reform. Dennis O. Flynn and Arturo Giraldez have argued that "by commuting tax payments exclusively to payment in silver the Ming 'Single Whip' tax reform indirectly mandated the production of export items which were acceptable in exchange for silver on the international markets". For Chinese peasants silk was the most easily produced export item, government fiscal policy thus provided a "powerful driving force" for silk production. Dennis O. Flynn and Arturo Giraldez, 'Silk for Silver: Manila Macao-Nagasaki Trade in the 17th Century', in Debin Ma. (ed.), *Textiles in the Pacific, 1500-1900. The Pacific World: Lands, Peoples and History of the Pacific, 1500-1900* (Aldershot: Variorum, 2005), p. 36.

[29] Kuhn, 'Textile Technology', pp. 288-89.

Sericulture spread to Italy in the twelve century. Here, the methods of sericulture and silk reeling developed largely independently from China.[30] By the sixteenth century, the Italian silk industry was the European leader in raw silk production and silk weaving.[31] Although French weaving overtook Italian in the eighteenth century, Italy retained its leadership in the production of raw silk in early modern Europe. Italy's success can be attributed to climatic conditions, strict organisation of production and quality control across all stages of silk production. Several Italian city states relied on silk exports for revenues, therefore states supported silk production through special institutional measures.[32] Institutions were created to enforce the production of high-quality raw silk and silk fabrics and also to protect trade secrets.[33]

The strictest control of production processes took place in Piedmont, which produced the most sought after raw and thrown silk in Europe.[34] The Piedmontese success is usually attributed to its superior reeling technology. However, as Claudio Zanier recently observed, the Piedmontese leadership in raw and thrown silk manufacture would have been impossible without a host of changes in sericulture, the training of labour, and the organisation of production that were implemented following

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[30] There is evidence that the system of reeling developed independently at least from the seventeenth century, Zanier, 'Pre-Modern European Silk Technology and East Asia', p. 153.

[31] Ernest Pariset, *Les Industries de la Soie* (Lyon: Imprimerie Pitrat Ainé, 1890), p. 422; Luca Molà, *Silk Industry in Renaissance Venice* (Baltimore: John Hopkins University Press, 2000), p. xv.

[32] See for instance: Mauro Ambrosoli, 'The Market for Textile Industry in Eighteenth Century Piedmont: Quality Control and Economic Policy, *Rivista di Storia Economica* 16 (3), 2000, p. 344.

[33] Carlo Poni, 'Comparing Two Industrial Districts: Bologna and Lyon in the Early Modern Period', in Pier Luigi Porta, Roberto Scazzieri, Andrew S. Skinner (eds.), *Knowledge, Institutions, and the Division of Labour* (Cheltenham: Edward Elgar, 2001), p. 204; Molà, *Silk Industry*, pp. xv-xvi.

[34] William Aglionby, 'Of the Nature of Silk, as It is Made in Piedmont', *Philosophical Transactions* 21 (1699), p. 184. See also: Zanier, 'Pre-Modern European Silk Technology', p. 114; Davini, 'History of Bengali Raw Silk', pp. 4-5, Ambrosoli, 'Market for Textile Industry', pp. 344 and 346.

the invention and adoption of the reeling machinery in the seventeenth century and without which would production of high-quality silk be impossible.[35] The precise date that the Piedmontese reeling machine was invented is unknown (figure 1.3).[36] However, reeling machines were well-documented in the second half of the seventeenth century and their use was made compulsory in the Kingdom of Savoy in 1667.[37] The reeling machine's main technical innovation was the invention of a system for crossing of silk threads.[38] Zanier named several benefits to crossing the silk threads. It 'squeeze[ed] water from the threads, remove[ed] impurities, render[ed] the thread more round, and compact[ed] the filaments in the thread'.[39]

[35] The 'Piedmontese reeling revolution' shaped sericulture and "compelled producers to raise cocoon quality". The new reeling machine required high technical expertise for its maintenance. The production of thinner thread necessitated higher-skilled reeling masters, which in turn needed a prolonged period of apprenticeship, usually up to seven years. Most importantly, the organization of labour in silk reeling changed in the late seventeenth century. Silk began to be reeled in factory-like establishments called silk filatures. Filatures represented an important point of departure from proto-industrial putting-out system. Zanier,'Pre-Modern European Silk Technology and East Asia', pp. 131-39; Davini, 'History of Bengali Raw Silk', p. 15.

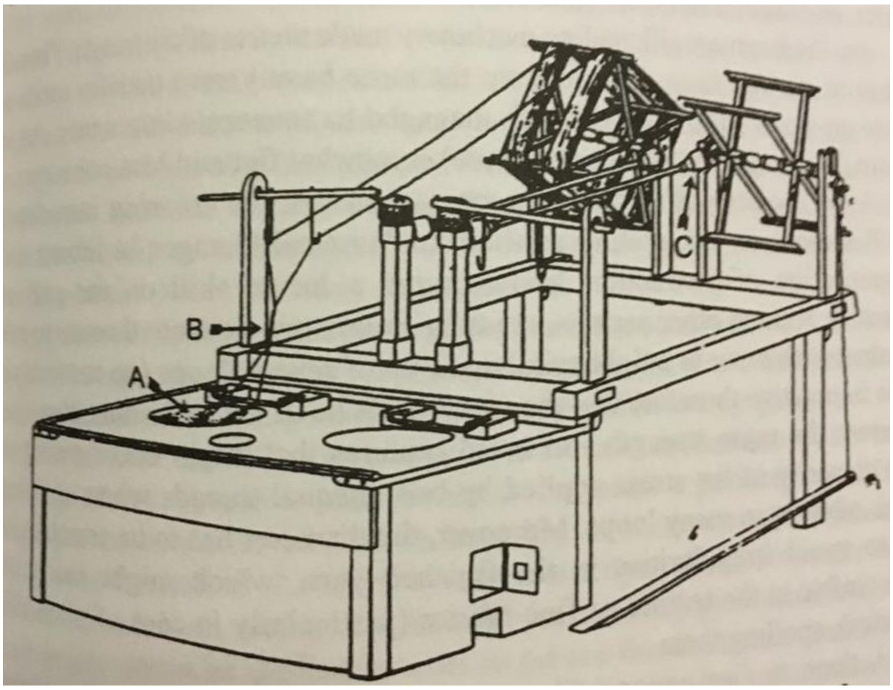
[36] The silk reeling machine depicted in Figure 1.3 represents an 1830s modification of the machine. However, it is a non-steam machine.

[37] Zanier, 'Pre-Modern European Silk Technology and East Asia', p. 128. Subsequent decrees detailed which reeling machines should have been used and their modifications in the eighteenth century.

[38] Ibid., p. 142 and pp. 146-49.

[39] Ibid., p. 130.

**Figure 1.3. A Piedmontese Reeling Machine**




*Source:* Piedmontese standard silk reeling machine, in Giacinto Carena, *Osservazioni ed Esperienze Intorno alla Parte Meccanica della Trattura della Seta nel Piemonte* (Torino, 1837) as reproduced from Claudio Zanier, 'Pre-Modern European Silk Technology and East Asia: Who Imported What?', in Debin Ma (ed.), *Textiles in the Pacific, 1500-1900. The Pacific World: Lands, Peoples and History of the Pacific, 1500-1900* (Aldershot: Variorum, 2005), p. 129.

## 1.4. The Initial Approach of the English East India Company to the Quality Problem

The sericultural and silk reeling practices adopted in India did not produce silk thread of quality suitable for export to Europe. Though observing multiple problems in silkworm rearing, the Company identified reeling as the most urgent problem. Initially, the Company decided to have all silk rewound before sending it to Britain. However, rewinding only solved the problem of inequality in skeins and it was detrimental to the quality of the silk filaments as they had to be soaked in water twice. [40] This practice also required more labour, gave rise to principal-agent problems and created the need for the supervision of the rewinders. These problems led the Company to experiment with new approaches.

Mounting dissatisfaction of manufacturers with the quality of the exported silk led to new and more coordinated efforts in order to improve the raw silk quality.[41] The Company sent silk specialists to Bengal from Europe to investigate the causes of the low quality of the raw silk production.[42] In 1757, Mr Richard Wilder, a specialist in all stages of silk production, was sent by the Company to Bengal.[43] The EEIC was especially eager to rectify the inequality of colour, fineness and length in skeins and improve the system of "marking" silk. All bales of raw silk had to be marked with letters A to E according to the fineness of the thread, with A being the finest and E the

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[40] [G.L.], 1775 fol.: Williamson, *Proposals*, p. 16. It was especially detrimental to the gloss "which is much and very visibly injured particularly in the lower letter of the country assortments". WBSA, CCC, Vol. 2, Prcds 5 March 1772, as cited in Davini, Una Conquista Incerta, p. 137.

[41] LSE Archives, W7204: East India Company, *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London, J.L. Cox, 1836); [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, pp. 13 and 16.

[42] IOR/E/4/861: 'China, Canton, Raw Silk, Mr. Wilder to Make Enquiries', India Office Records and Private Papers, p. 980.

[43] IOR/E/4/616: 'Bengal Raw Silk to be Investigated by Richard Wilder', Bengal Supplement 25 March, 1757, pp. 557-60. Richard Wilder was considered by the Court of Directors to be a "Person extremely well qualified" in all stages of silk production. He was contracted by the Court on 25 March 1757 for a five-year period of service in Bengal. His task was to investigate the reasons for production of low-quality silk in Bengal and to make amends. Wilder was paid £400 annually and £10 for subsistence, he was also provided with accommodation. During his time in India he was also to make a journey to China but the Company eventually realised that Wilder would be of no use in China because he would not be able to get involved in production there. His contract was extended for another two years during which he was allowed to get involved in private trade (with exception of trade in silk). Wilder eventually stayed in the Company's service until his death in 1765. IOR/E/4/616, March 25 March 1757, pp. 557-60; IOR/E/4/617, 19 February 1762, p. 400; IOR/E/4/617, 15 February 1765, p. 1075; IOR/E/4/619, 17 March 1769, p. 339; IOR/E/4/620, 23 March 1770, p. 220.

coarsest.[44] This system was regularly ignored in Bengal: often bales marked with letters D and E contained finer silk than B and C. The Company warned from London that "these are Errors which must be looked into and rectified or the Company must drop the Importation of the Article".[45] The five categories made it more likely that the silk qualities would be mismarked than if there were fewer categories. However, it was typical to mark silk into five qualities that were marked A to E for the European market.[46]

Apart from inspecting the production methods and the quality of the raw silk, the Company also expected Richard Wilder to supervise the rewinding of Putney at the Company's factory in Calcutta.[47] This was conceived as an experiment so that the Company could establish the cost of rewinding and identify the specific instructions that should be given to the rewinders in order to improve the quality of the silk. However, it was also suggested that as much raw silk as possible should begin to be rewound at the Company's factory in Kasimbazar directly under Wilder's supervision.[48] Kasimbazar

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[44] IOR/E/4/616: 'Bengal Raw Silk to be Investigated by Richard Wilder', Bengal Supplement 25 March, 1757, p. 557.

[45] Ibid., p. 558.

[46] According to the Company's documents it was common in Europe to divide silk according to the fineness into five categories marked with letter A to E, where A was the finest with the lowest number of filaments in a thread. The Company attempted to implement such system also in Bengal. The secondary literature on silk industry does not mention this system of marking. However the EEIC's documents imply that this system was widespread and that buyers relied on it. The literature on the European silk industry mentions different systems of categorising the quality of silk so this one was probably not the only one. Luca Molà for instance points to the fact that silk was divided into categories according to the region of origin and several other characteristics. Molà, *Silk Industry*, pp. 55-56.

[47] IOR/E/4/616, 'Bengal Raw Silk to be Investigated by Richard Wilder', 25 March, 1757, pp. 656-57.

[48] Ibid., pp. 656-57.

was the main area of silk production in Bengal and in the 1750s the Kasimbazar factory was the principal factory procuring raw silk from intermediary merchants.[49]

Richard Wilder was the Superintendent of the Company's Bengal silk investment from 1757 until his death in 1765. He was succeeded by John Chamier, who was a former 'free merchant' employed by the Board of the Kasimbazar factory because of his knowledge of raw silk production.[50] Joseph Pouchon was also employed by the Board, although he was to work under Chamier's direction.[51] Both Richard Wilder and Joseph Pouchon attempted to implement several changes to reeling technologies.[52] However, their changes remained experiments, never becoming widely implemented practices. Pouchon, for instance, was able to produce a sample of raw silk reeled according to a method he invented, however the Company did not consider the experiment economically viable.[53]

The EEIC's Factory Records from the Kasimbazar silk factory from late 1750s are an excellent source of information about the new practices that the Company attempted to adopt in the Bengal silk industry.[54] The role of the Kasimbazar factory

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[49] The English East India Company used the term 'factories' for trading posts. The EEIC's factories procured export goods but did not directly produce them.

[50] IOR/G/23/13:' Factory Records: Kasimbazar, 1757-59, 19 January 1759', India Office Records and Private Papers. Before John Chamier became a silk superintendent he was a member of the Board of the Kasimbazar factory. The Court had a very favourable opinion about Chamier's experience with silk production and reported to the Board in Bengal that Chamier "has a complete knowledge of the Manufacture of Raw Silk, having been bread up and many years engaged in the Silk Trade". IOR/G/23/13:' Factory Records: Kasimbazar, 1757-59, 19 January 1759', India Office Records and Private Papers; IOR/E/4/617, 15 February 1765, p. 1075.

[51] IOR/E/4/617, 15 February 1765, p. 1075; IOR/E/4/619, 17 March 1769, p. 339; IOR/E/4/620, 23 March 1770, p. 220.

[52] LSE Archives, W7204: East India Company. *Reports and Documents*, p. v.

[53] This method was different than the Piedmontese reeling method adopted later. J. Geoghegan, *Some Account of Silk in India, Especially of the Various Attempts to Encourage and Extend Sericulture in that Country* (Calcutta: Department of Revenue and Agriculture, 1872), p. 2.

[54] IOR/G/23/13: 'Factory Records: Kasimbazar, 1757-59', India Office Records and Private Papers.

(established in 1658) was to procure raw silk as well as finished silks for the export markets.[55] No silk was produced in the factory itself as before the 1760s the Company relied exclusively on a putting-out system. Many techniques proposed by the Company's silk specialists could not be adopted because they were opposed by the winders, for example knotting of the silk was not implemented.[56] Silk knotting was proposed to rectify the inequal widths of threads; it was also supposed to make the silk thread rounder.[57] Although, it was seemingly a simple adjustment to the established method of re-reeling, the implementation of knotting proved to be an insurmountable problem.

Initially, the Kasimbazar Factory demanded the winders to knot the silk according to the method used in England. However, the winders refused to implement the knot and deserted their work. The factory records summarized the consequences as follows:

> the Method of knotting Silk proposed by Mr Wilder being introduced […] into the Nacaud Connah caused a great Mutiny and desertion among the Winders, as they were not able to wind off so great a Quantity as they formerly could by the great Delay caused in endeavouring to the Knott proposed by Mr Wilder.[58]

To enable the introduction of knotting the EEIC had to agree with the introduction of a simpler knot which was designed by the winders themselves.[59] However, the Company

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[55] Thomas Bowrey, *A Geographical Account of Countries round the Bay of Bengal, 1669-1679* (Cambridge: Hakluyt Society, 1905), p. 213.

[56] This illustrates the lack of control of the EEIC over the agrarian economy of Bengal. The EEIC had to rely on market incentives and could not control the existing silk market. Benoy Chowdhury, *Growth of Commercial Agriculture in Bengal 1757-1900* (Calcutta: R. K. Maitra, 1964), vol. 1, p. i; Davini. 'Una Conquista Incerta', p. 7.

[57] G/23/13: 'Factory Records: Kassimbazar, 1757-59', pp. 93-94, 96 and 108.

[58] IOR/G/23/13, 7 October 1758, p. 108

[59] Ibid.

faced further problems, the winders refused to knot the finest sorts as these sorts took considerably longer to knot.[60] Moreover, the winders would only start knotting the silk when their allowance was increased.[61] In spite of the concessions on the part of the Company, it remained difficult to convince the winders to knot the silk carefully and complaints against the quality of knotting increased.

The Company encountered similar problems with the compliance to the musters of silk (samples of silk). Musters were supposed to show the qualities of the product offered to the Company. The Kasimbazar Factory based its decisions about the price it would pay for silk from a particular merchant agent and the quantity to be purchased on the musters of re-reeled silk it received. Musters were supposed to indicate the quality of the whole quantity of silk purchased. However, the silk procured by the Company often did not resemble the musters send out.

The problems encountered in adopting the knot and matching the quality of silk thread to the musters are indicative of several issues. First, they show a lack of power of the Company to enforce the adoption of new practices. The winders were independent economic actors who often chose the merchants they worked for. In many cases they chose to work for merchants who were not in the service of the EEIC. The factory records contain many reports that show that orders from London could not be fulfilled due to a lack of winders working for the Company.[62] Second, they show that the Company was subject to market laws. The Company was aware that it could not coerce the winders and that the only way to encourage them to adopt new practices and induce them to follow the Company's directives was to increase their wages. Hence, the board of the Kasimbazar factory increased the allowance given to the winders on the grounds

[60] Ibid., 28 February 1759.

[61] Ibid.

[62] IOR/G/23/13, 12 August 1758, p. 83; IOR/G/23/13, 30 August 1758, p. 94.

of it “being assured that all other measures taken for the Improvement of the Quality, or increase of the Quantity of Silk required for the Company, will be ineffectual without it”.[63] However, this increase did not lead to a significant improvement in the quality of the raw silk. First, the changes of reeling practices were too marginal to lead to a significant improvement in quality. Second, even such minor changes were not effectively enforced due to the Company’s reliance on a putting-out system.

## 1.5. Organization of Raw Silk Production before 1769

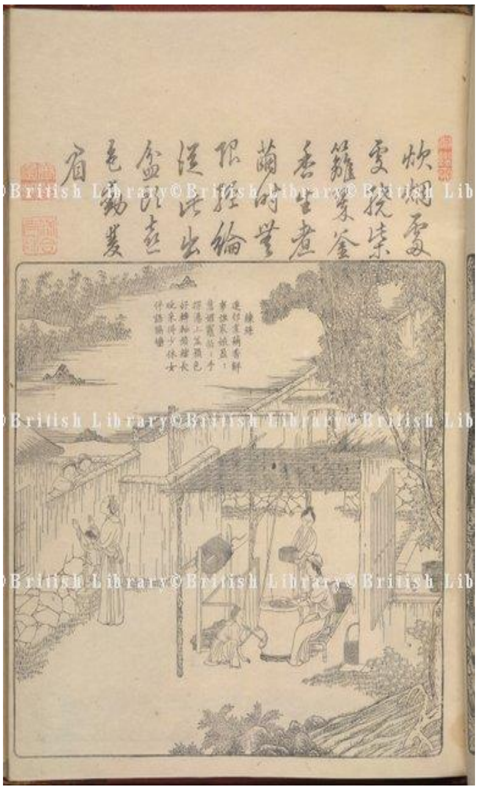
The organizational, technical and gender divisions of labour of the eighteenth-century silk industries in India, China, and Europe show many differences. The geographical division of labour in India, was however, similar to Europe and China. In all these regions, silkworm rearing and mulberry cultivation were carried out in rural areas. Silk reeling was also mostly carried out in rural areas or in close proximity to sericulture.[64] These regional similarities are due to the technological limitations of eighteenth-century silk production – there was no method to preserve cocoons for long periods of time, and without timely reeling the quality of cocoons deteriorated.[65]

[63] Ibid., 15 January 1759.

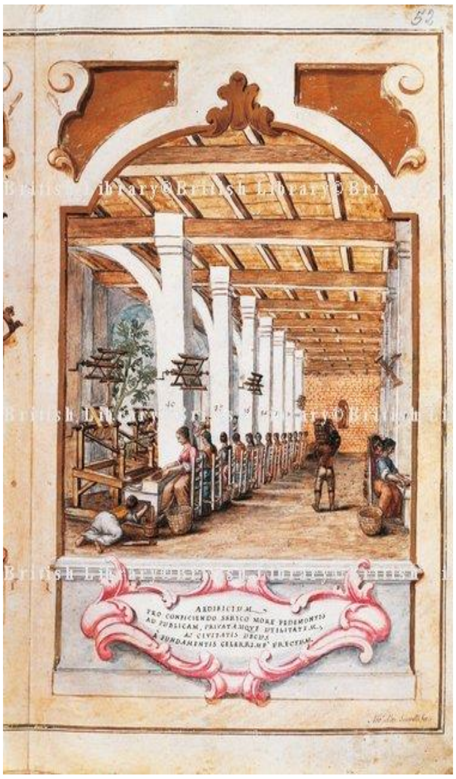
[64] Davini, ‘History of Bengali Raw Silk’, p. 6.

[65] The long-distance transportation of cocoons was not possible until the method of the drying of cocoons developed in the nineteenth century because without drying cocoons easily got spoilt. Claudio Zanier, ‘Silk and Weavers of Silk in Medieval Peninsular India’ (Unpublished Paper presented at the Conference ‘Historical Systems of Innovation: The Culture of Silk in the Early Modern World (14th-18th Centuries)’, Berlin, December 2010).

**Figure 1.4. Images of Silk Reeling in China and Piedmont**



*Source*: British Library, 081649, Geng Zhi Tu – Silk Reeling, 15268.b.2, Jiao Bingzhen, China, 1696, © British Library.



*Source*: British Library, 10327952, Piedmontese Silk Manufacturing, Antonio Alessandro Scarselli, Miniature, Italy, 18th Century, © De Agostini/British Library Board.

Before the EEIC's direct involvement in silk production, gendered divisions of labour were similar in many instances in Bengal, Europe and China. Women reared silkworms, while mulberry cultivation was a male task.[66] There were however differences. In Europe and China silk reeling was a female occupation; in India, however, it was undertaken by men and women (Figure 1.2).[67] Figure 1.4 illustrates the gender division in Europe and China. When compared to Figure 1.2, the differences in gender division among China, Europe and Bengal clearly stand out. In India men were

[66] Jordan Goodman, 'Cloth, Gender and Industrial Organization towards an Anthropology of Silkworkers in Early Modern Europe', in Cavaciocchi (ed.), *La Seta in Europa*, p. 231.

[67] Kuhn, 'Textile Technology', p. 204; Goodman, 'Cloth, Gender and Industrial Organization', p. 231.

involved if reeling was carried out by cuttanies instead of being done in the households.[68] As argued by Jordan Goodman, the gender division of labour in the silk industry was different compared to other European textile industries. Goodman illustrates how at least the first part of the proverb 'women spin and men weave' was inaccurate for the European silk industry, as throwing and spinning were typically done by men.[69] In India men were involved in the production of silk even more heavily. Moreover, the Company's demand for raw silk created new demand for male re-winders.[70]

In China silk production relied predominantly on small-scale, peasant households. Several imperial workshops were established but large scale-production was not widespread.[71] Sericulture was a labour-intensive activity and as argued by Dennis O. Flynn and Arturo Giraldez, the supervision of sericulture (the processes of mulberry cultivation and silkworm rearing) would have been expensive. Therefore, they argue that "decentralized production evolved as the cost effective choice".[72] Moreover, reeling was also organised on the household level, particularly due to inexpensive hand-reeling machines that peasants could afford.[73] Therefore, the organisation of the Chinese silk industry was similar to the Bengal silk industry, although in China the government

[68] This is illustrated in [G.L.], 1775 fol.: Williamson, *Proposals*, pp.17-8, it can be observed also from the images.

[69] Goodman, 'Cloth, Gender and Industrial Organization', pp. 231-34.

[70] Although this is not explicitly stated in any document, the materials make no allusion to re-releers being female.

[71] The number of imperial workshops expanded particularly during the seventeenth century. It is said that the workshops in Hangchow, Nanking and Soochow employed some 7,000 artisans and 1,863 looms in 1685. Flynn and Giraldez, 'Silk for Silver', p. 54.

[72] Ibid., p. 36.

[73] Kuhn, 'Textile Technology', p. 337.

was active in promoting silk production. Silk production was particularly promoted through taxation, which indirectly favoured an increase in the quality of production.[74]

The organization of production was a key difference between silk industries in Europe and India. Sericulture and silk reeling were less centralized and less specialized in India than Europe.[75] In Europe and India sericulture was carried out at household level but because of the different number of harvests a year, the requirement of labour differed between the two world regions. In Europe there was one crop a year and peasants did not need to focus exclusively on sericulture. In Italy, the major European producer of raw silk, mulberries were cultivated on the edges of fields or intermixed with other crops and their cultivation did not require large amounts of labour.[76] In Bengal there were between three and six harvests a year and mulberry trees were cultivated as shrubs, which meant that their cultivation required more labour and land than in Italy.[77] If a peasant family decided to engage in sericulture in Bengal, the whole family had to be involved: men in mulberry planting, women in silkworm rearing and silk reeling. As a result sericulture was a "marginal, and low intensity activity" in Italy, it was a comparatively more land- and labour-intensive in Bengal.[78]

In Europe sericulture became a highly centralized sector under the influence of merchant-entrepreneurs and guilds.[79] Silk reeling was also highly centralized. Master artisans retained control over specialised knowledge and possession of their tools but they came under the control of the merchant-entrepreneurs and the jurisdiction of guild

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[74] Flynn and Giraldez, 'Silk for Silver', p. 36.

[75] Davini, 'History of Bengali Raw Silk', pp. 7-9.

[76] Ibid., p. 8.

[77] Ibid., p. 8, IOR, Bombay (Misc. Public Documents, etc.)., 1793.m.17: 'Letter from Giuseppe Mutti'.

[78] Davini, 'History of Bengali Raw Silk', p. 8.

[79] Luce Boulnois, *The Silk Road* (London: Allen and Unwin, 1966), p. 214; Molà, *Silk Industry*, p. xiv; Franco Franceschi, *Florence and Silk in the Fifteenth Century: The Origins of a Long and Felicitous Union* (Fiesole: Edizioni Cadmo, 1995), pp. 5 and 7-9.

regulations.[80] In these cases in which silk was produced through a putting-out system, merchants owned the material throughout the whole production cycle and artisans were paid for their work by the piece.[81] The most advanced systems of raw silk production in Europe were rather different. Several new features in the organization of production such as reeling in factory-like establishments, time wages in reeling etc. were developed in Piedmont in order to ensure the high-quality reeling and efficient production.[82]

In comparison to Europe, the system of organization of production in India allowed the producers more independence.[83] Raw silk was produced under a system similar to the European putting-out system.[84] However, as the towns and villages which cultivated mulberries and reared silkworms were scattered, alongside the EEIC's requirement that silk needed to be rewound before exportation, meant that production of silk thread became increasingly fragmented.[85] There were at least three stages: mulberry planting and silkworm rearing; reeling; and the re-reeling of silk and each was carried out by a different producer.

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[80] Molà, *Silk Industry*, p. xiv, In Florence spinners, weavers and dyers were forbidden to establish their own organizations and had to follow the regulations of the silk guild. In Lyon, the sector was regulated by La Fabrique Lyonnais. Franceschi, *Florence and Silk*, pp. 9 and 16.

[81] Franceschi, *Florence and Silk*, pp. 8-9.

[82] Davini, 'History of Bengali Raw Silk', p. 15.

[83] Riello, *Cotton*, pp. 62-64; Bishnupriya Gupta, 'Competition and Control in the Market for Textiles: Indian Silk Weavers and the English East India Company in the Eighteenth Century', in Riello and Roy (eds.), *How India Clothed the World,* pp. 292-97.

[84] The putting-out system varied in different parts of Europe. Thus, it is no surprise that it is still disputed whether the concept can also be applied to pre-modern Asia. In the case of the silk industry it is possible to argue along the lines of Frank Perlin, who argued that the system of organization of production in pre-colonial South Asia was similar to that of the rural industries of Europe. Frank Perlin,'Proto-Industrialization and Pre-Colonial South Asia', *Past and Present* 98 (1), 1983, pp. 84-94.

[85] [G.L.], 1775 fol.: Williamson, *Proposals*, p. 15. The organization of production in pre-modern India was dependent on a large number of intermediaries also in other sectors. For cotton textile production in India see: Riello, *Cotton*, pp. 63-64.

## 1.6. The System of Procurement of Bengal Raw Silk for the British Market

As for other commodities traded by the English East India Company, the EEIC was dependent on intermediary merchants to procure raw silk. Intermediary merchants linked export merchants, such as the EEIC and producers. The Company's reliance on intermediaries however, meant that the European companies were often unable to procure the quantity and quality of goods needed and could not reprimand the deceitful behaviour of some merchants. These problems were imbedded in the procurement system.

In the case of raw silk, the system of procurement was also highly fragmented with many intermediaries involved in the process. The necessity of rewinding 'country-wound' silk introduced an additional stage of production and further complicated the procurement process. The Company lacked the power to enforce the supply of the quantity and quality of silk it demanded.

The most widely used system of procurement by the European companies was the dadni system.[86] In the dadni system, a merchant was contracted to supply the Company with an agreed quantity of a specific commodity for which he received an advance payment, called 'dadni'.[87] Apart from its inability to fully control the quantity and quality of procured goods, the EEIC often faced the threat of losing its investment as merchants "refused to give security for the dadni advanced to them".[88] In 1753 the

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[86] Sushil Chaudhuri, 'Merchants, Companies and Rulers: Bengal in the Eighteenth Century', *Journal of the Economic and Social History of the Orient* 31 (1), 1998, p. 76. Dadni merchants retained a great deal of power because they could act together and stand against the EEIC. Rila Mukherjee, 'The Story of Kasimbazar: Silk Merchants and Commerce in Eighteenth-Century India', *Review Fernand Braudel Center* 17 (4), 1994, pp. 500 and 520; Davini, 'Una Conquista Incerta', pp. 23-24.

[87] Chaudhuri, 'Merchants, Companies and Rulers', pp. 76-77.

[88] Ibid. p. 77.

EEIC decided to switch to the gomasta system.[89] Gomastas were paid agents who procured goods on behalf of the Company.[90] The EEIC was not the first European company to switch to the gomasta system. The Dutch Company experimented with this system from 1747-49. However, the gomasta system also produced problems. In particular, the Dutch Company experienced "considerable difficulty in finding a sufficient number of capable gomastas and in maintaining uniformity of standards".[91] Similarly, the EEIC also encountered several problems using the gomasta system as can be illustrated for raw silk procurement.

The gomasta system was considerably fragmented and the silk passed through the hands of several intermediaries before reaching the EEIC (Figure 1.5). Before the cultivating season started, the EEIC had to advance money to their gomasta merchants, who then advanced it to the principal producers for the promise of silk. The system was further fragmented because these merchants employed other intermediaries. The principal brokers, Dellolls, employed agents of their own called Pycars to purchase Putney. Pycars were supplied with money by the Dellolls and they were to advance this money to peasants so that they could purchase silkworm eggs, prepare hats in which to

[89] This meant very sudden decline of power for the dadni merchants. Mukherjee, 'Story of Kasimbazar', p. 531.

[90] Roberto Davini in his PhD thesis argues that the gomasta system gave the Company more power over producers. The system of procurement became more bureaucratized, contracts were written and specified quantity and quality of goods to be delivered and the deadline for their delivery were set in these contracts. However, in practice the system did not work as smoothly as intended and the problems I describe below illustrate that the gomasta system was not a solution to the problems of the quality of silk. Moreover, it is questionable whether the system increased the power of the EEIC over procurement. The gomasta system was unable to eliminate intermediary merchants from the system of procurement or make them accountable, thus the EEIC continued to face principal-agent problems. See: West Bengal State Archive (WBSA), Committee of Circuit at Cossimbuzar, Letter from Pattle to Committee of Circuit, 25 July, 1772 as cited in Davini, 'Una Conquista Incerta', p. 28.

[91] Chaudhuri, 'Merchants, Companies and Rulers', p. 86.

rear silkworms, till the land for the planting of mulberries, and pay Cuttanies for silk reeling.[92]

**Figure 1.5. Actors Involved in the Procurement of 'Country-Wound' Silk in Bengal, 1750s**

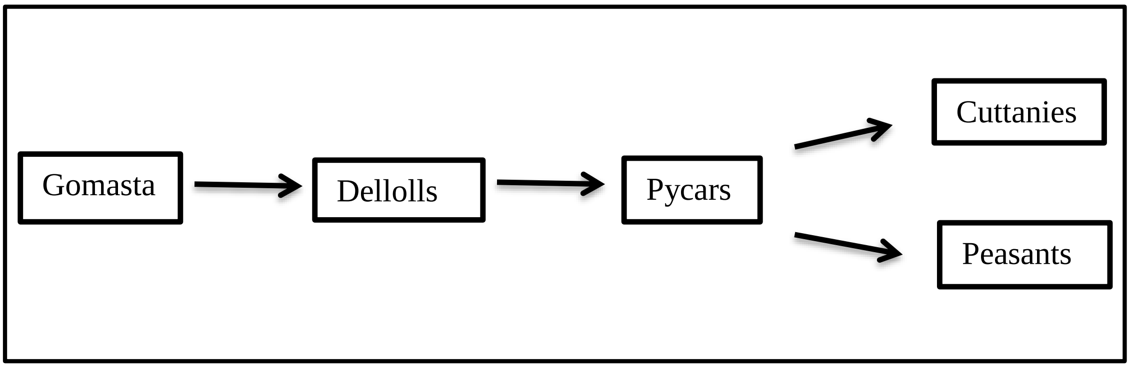
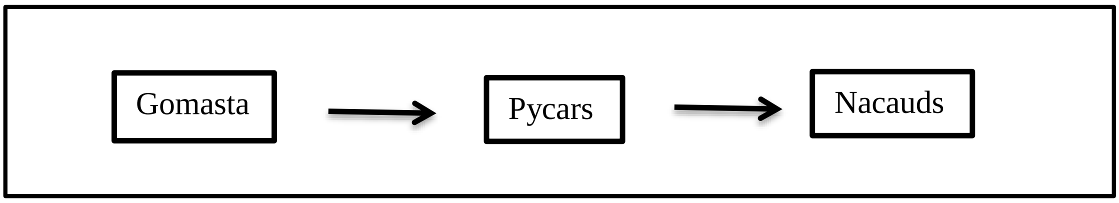



**Figure 1.6. Actors Involved in the Re-Reeling of Silk in Bengal, 1750s**




Once procured, the Putney had to be re-reeled. Re-reeling was done by nacauds under the supervision of the head winders, the Sirdars. The employment of Sirdars was crucial because winders were prone to shirking. They needed supervision because, apparently, otherwise they would not wind properly, and would steal the Putney, tear it or take the advance and work for someone else.[93] The Kasimbazar factory records show that the EEIC also relied on gomastas for the rewinding of silk (Figure 1.6). In each aurung (silk region) the Company advanced money to a gomasta, who employed winders for

[92][G.L.], 1775 fol.: Williamson, *Proposals*, pp. 15-17.

[93] Ibid., p. 17.

rewinding Putney into five or six qualities, under the A-F quality categories.[94] The Company advanced money to the gomastas around the beginning of each harvest season. The Commercolly factory required the gomastas to send musters of the rewound silk before it made a decision about the quantity of silk it was going to purchase from a particular aurung.

The gomastas who proved reliable were advanced higher amounts of money before they sent musters. Finding reliable gomastas often proved a difficult task. In several cases gomastas did not have enough rewinders in their service.[95] The Kasimbazar factory faced deceitful behaviour by gomastas who sent musters of higher quality than the silk procured or overcharged the Company.[96] Worse still, in some cases the factory could not even dismiss such gomastas as it would negatively affect the procurement of other goods. Thus was the case of Hissenda, a gomasta involved in both raw silk and piece goods procurement. When the servants in the Kasimbazar factory compared the prices Hissenda charged the Company for raw silk procurement with the ones charged by one of the Assamys – gomastas not in the service of the EEIC – they found that:

> he [Hissenda] has overcharged the Goods he has delivered into the Company's Cottah here, and by that means endeavoured to defraud his Employers of sicca rupees 8427 7 Annas 3 Pice [£913] but notwithstanding we have plainly discovered the above yet we are under a Necessity of continuing him at present in the provision of the Investment, he is already providing for should we turn him out of his Employ, and take the Assammys under our own Care, the Silk

[94] The five letter system was sometimes expanded into six when the silk of letter E was very coarse.

[95] IOR/G/23/13, 5 December 1757, p. 2, IOR/G/23/13, 30 December 1757, p. 10; IOR/G/23/13, 24 September 1758, p. 105

[96] For instance, IOR/G/23/13, 21 October 1758, p. 114.

> Piece Goods Investment would fall greatly short, as we are already informed the Weavers are beginning to sell their goods provided for the Company to other Merchants".[97]

This case shows just how difficult the situation was for the Company when the procurement of raw silk was involved. It is not surprising that the adoption of new reeling practices proved impossible. Neither the system of procurement of raw silk, nor the putting-out system under which raw silk was produced were favourable to introducing changes to production techniques.

## 1.7. Conclusion

The English East India Company faced several obstacles in the trade of Bengal raw silk. As the silk exported from Bengal by the EEIC had to compete with superior raw silk from Italy and China as well as with silk from Turkey and Spain, quality became an issue of central importance for the Company. The raw silk produced in Bengal was of too low a quality to gain a significant market share in Britain. Comparatively lower quality raw silk was manufactured in Bengal due to the production methods adopted, which were technologically inferior. Moreover, in India high-quality silk production was not promoted by the government as in Italy and China. In order to expand its trade the English East India Company decided to take steps to improve the quality of Bengal raw silk. The initial approach of the Company was to contract reelers to re-reel the so-called 'country-wound' silk. As this step did not lead to a sufficient increase in the quality of the silk, the Company's silk specialists attempted to implement wider changes to silk reeling practices. However, enforcement of changes under a putting-out system

[97] IOR/G/23/13, 14 July 1758, p. 70.

was impossible. The EEIC thus, started to experiment with silk reeling straight from cocoons under its own direct supervision in establishments owned by the Company.

# CHAPTER 2

## The English East India Company's Stake in the Bengal Silk Industry

> […] according to the most considerable Traders and Manufacturers; it appears that the staple of the Bengal Silk is in quality equal to and would answer all the purposes of the Italian or Spanish sorts if reeled in the same manner so as to render it easier to wind and to work with less waste and that with such advantages it would sell at a much higher price than at present […], but if it would wind and Reel as fast as the Piedmont and Italian Sorts 500 Bales would not be too much for this market and fetch from 25 to 30 per cent more than it letts for at present and the lower letters proportionately, even those of D and E might be so perfectly manufacture for answering the uses of the Spanish and Calabria Silk as to increase 20 per cent on the present price and no quantity be too large for sale here.[1]

This chapter explores the factors that underpinned the Company's perception that Bengal raw silk was one of "the choicest goods" and induced the Company to become a silk manufacturer in Bengal.[2] This chapter argues that the interest in Bengal raw silk was aided by changes to the EEIC's finances in the aftermath of the Battle of Plassey (1757) and the acquisition of the dewany of Bengal, Bihar, and Orissa (1765). It also argues that the promotion of silk was informed by the British government's support of the British domestic silk industry. The British government was keen to secure supplies of raw silk from colonial settlements and supported various initiatives in this respect.

[1] IOR/E/4/619, 31 January 1770, pp. 653-55.

[2] IOR/E/4/621: 'Bengal Despatches, 24 November 1772', p. 380.

The creation of the Company's 'Bengal Silk Enterprise' can be placed among the "attempts to improve the quantity and quality of goods in order to transfer the Dewany revenues to Britain".[3] Following Huw Boven's argument, I argue that the EEIC's venture of the Bengal silk industry was part of a strategy directed at remitting revenues from territorial acquisitions through an increase in the volume of goods imported into Britain.[4] The importance that was attributed to the expansion of the silk trade is conveyed in the East India Company's correspondence and documents in which raw silk was ascribed the status of one of the 'choicest' piece goods with potentially large returns for the Company.[5]

In order to bring the attempts of the EEIC into a broader perspective this chapter first considers the initiatives to introduce silk processing in other parts of the British Empire. Second, it examines the changes to the Company's finances after 1765 when the EEIC gained the rights to tax Bengal. Third, it considers the factors that facilitated the Company's interest in expanding the trade in Bengal raw silk. The chapter concludes by exploring the role of mercantilism in facilitating the Company's commitment to its Bengal silk venture.

[3] Huw V. Bowen, *Revenue and Reform: The Indian Problem in British Politics, 1757-1813* (Cambridge: Cambridge University Press, 1991), p. 21.

[4] Id., 'Investment and Empire in the Later Eighteenth Century: East India Stockholding, 1756-1791', *Economic History Review* 42 (2), 1989, p. 189; The importance of the import trade for repatriating wealth from India is also recognized by Anthony Webster, 'The Political Economy of Trade Liberalization: The East India Company Charter Act of 1813', *Economic History Review* 43 (3), 1990, p. 408.

[5] For instance IOR/E/4/621: 'Mr Wiss, Superintendent of Silk Trade, in Bengal Despatches, 24 November 1772', India Office Records and Private Papers, pp. 379-80.

## 2.1. Initiatives to Introduce Silk Processing Technologies in the British Empire

The attempt to introduce new methods of silk reeling into Bengal was not an isolated experiment. Trading companies and settler organizations such as the Trustees for the Establishment of the Colony of Georgia and the Virginia Company were keen to adopt sericulture and silk processing technologies also in other parts of the British Empire, especially in North America. All these attempts were supported by the British government through exemption on tariffs etc. – thus attesting the government's interest to secure imports of raw silk from overseas dependent territories. It is important to perceive the English East India Company's attempts to expand import of Bengal raw silk to Britain in the framework of other initiatives because the Company's plan was guided by similar logic. At the same time, however, the attempt to introduce new silk processing technologies to Bengal has a special role in the history of silk technology transfers to the British colonies. In comparison to attempts to adopt sericulture and silk reeling in North America, silk production in Bengal was successful. Moreover, it was the only project that was carried out in a country already producing raw silk.

The first attempt to promote the overseas production of raw silk for the market took place in the seventeenth century and was initiated by James I in 1623.[6] The plan and the king's involvement was described by L. P. Brockett: "he [James I.] sent over the mulberry trees and the silk-worm eggs, and directed the company that who were

[6] Gerald B. Hertz, 'The English Silk Industry in the Eighteenth Century', *English Historical Review* 24 (96), 1909, p. 716. Attempts to produce raw silk in England and its colonies were among the "new agricultural projects" initiated in the sixteenth and seventeenth centuries. Joan Thirsk, *Economic Policy and Projects: The Development of a Consumer Society in Early Modern England* (Oxford: Oxford University Press, 1978), p. 7; Charles E. Hatch, Jr., 'Mulberry Trees and Silkworms: Sericulture in Early Virginia', *Virginia Magazine of History and Biography* 65 (1), 1957, p. 3.

managing the colony to follow up his order by suitable legislation."[7] In spite of the encouragement in the form of financial rewards for planters producing silk and fines for those failing to cultivate mulberry trees, the project was unsuccessful. In comparison to tobacco production, silk was less profitable and the project of promoting raw silk production in Virginia was abandoned.[8]

Georgia was another of the several North American colonies that introduced raw silk production. According to Ben Marsh, the trustees advertised their keen interest to cultivate silk (together with wine) in order to appeal to the British Parliament and public to gain support and funding for the setting up of the colony.[9] Marsh contends that in the first few years after the new colony was established, the trustees of the Georgia colony devoted considerable effort and funding to the implementation of silk production. The biggest challenge they faced was to secure a labour force willing to take up silk production and skilled enough for the task.[10] To attract labour, the trustees offered financial, technological, and educational support as well as salaries, bounties, and bonuses.[11] They also imported equipment and specialist literature, and institutionalised apprenticeship.[12] In spite of these efforts, the experiment turned out to be unsuccessful in the long term. Georgia lacked labour sufficiently skilled in silk production to succeed. By the 1780s sericulture was practically extinct. Mulberry

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[7] Linus Pierpont Brockett, *The Silk Industry in America: A History* (New York: George F. Nesbitt & Co., 1876), p. 26.

[8] Hatch, Jr., 'Mulberry Trees and Silkworms', pp. 4-5, 9 and 50-61.

[9] Ben Marsh, *Georgia's Frontier Women: Female Fortunes in a Southern Colony* (London: University of Georgia Press, 2007), p. 53.

[10] James C. Bonner pointed to the fact that labour was generally scarce in Georgia and that the fact that sericulture could rely on the cheaper labour of women and children was consired as an advantage. However, the labour force in Georgia lacked knowledge of sericulture. James C. Bonner, 'Silk Growing in the Georgia Colony', *Agricultural History* 43 (1), 1969, p. 143-44.

[11] Ibid., p. 144.

[12] Marsh, *Georgia's Frontier Women*, p. 55.

cultivation proved to be competing for land with rice and corn cultivation. Furthermore, knowledge of sericulture and silk reeling never became widespread in Georgia.[13]

Attempts to adopt silk production were made also in South Carolina and Connecticut in the eighteenth century. The silk produced in South Carolina was supposed to be of very high quality. Brockett argued in the nineteenth century that South Carolina's raw silk was "said by Thomas Lombe… to have been equal or superior to any of the Italian".[14] In Connecticut, silk production was taken up in the 1750s and was supported by bounties towards mulberry cultivation. Silk production was attempted in various other places in North America such as New Jersey, New York, Delaware, and Maryland. However, none of these places became important producers of raw silk.[15] These attempts either failed altogether or at best, silk production was carried out on a small scale as a domestic manufacture until the middle of the nineteenth century when it finally disappeared.[16]

According to Hertz, attempts to establish raw silk production in the American colonies failed because of high wages. Hertz points to the fact that both nominal and real wages were higher than in Italy – the main European producer of reeled and thrown silk.[17] Slave labour could not be used because of the skills required. Ben Marsh argues that the high costs of labour combined with a lack of knowledge of sericulture and silk

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[13] Marsh, *Georgia's Frontier Women*, pp. 56 and 59-61; Bonner, 'Silk Growing in the Georgia Colony', p. 144.

[14] Brockett, *Silk Industry in America*, p. 29.

[15] Nelson Klose, 'Sericulture of the United States', *Agricultural History* 37 (4), 1963, pp. 225-34.

[16] Ibid., pp. 34-35.

[17] Hertz, 'English Silk Industry', p. 718. He agrees with John Habakkuk's thesis that the high wages and labour scarcity induced the adoption of labour-saving technologies in Antebellum America. John Habakkuk, *American and British Technology in the Nineteenth Century: The Search for Labor-Saving Inventions* (London: Cambridge University Press, 1962), pp. 4-11.

reeling were the prime reasons for the failure of raw silk production in Georgia.[18] Similar explanations for the failure of raw silk production in the American colonies were also given by Brockett.[19] Yet he also draws attention to the competitive pressures that silk production was subject to in the colonies. In Virginia, silk had to compete with tobacco cultivation, and in Georgia with cotton and agricultural crops.[20] Moreover, both Brockett and James C. Bonner observed the fact that the export trade was badly affected by the War of Independence, which left the American silk producers without a market.[21]

Another factor that undermined silk processing in North America was 'imperfect reeling'. Problems with the quality of reeled silk were experienced in most of the areas of silk production in the world, perhaps only with the exception of Italy and China. This was the result of the technological problems, principal-agent problems, and the low quality of cocoons. Often one or more of these factors were present simultaneously, as for example in Bengal. It has been argued that in North America the problem lied principally in reeling, as noted by Brockett when he observed that the cocoons were excellent but that the reeling was very poor.[22] The poor quality of reeled silk had damaging effects on the quality of woven textiles and was thus frequently addressed as a matter of priority. In most of North America hand-reel was used for reeling. In Georgia attempts were made to innovate silk reeling. The trustees in Georgia relied mostly on Italian immigrants to acquire the necessary knowledge of silk processing. Among the people who were entrusted to promote silk production in Georgia was Pickering Robinson, a silk specialist who was later commissioned by the

[18] Marsh*, Georgia's Frontier Women*, pp. 56-61.

[19] The importance of having access to cheap labour for succeeding in the production of raw silk was also pointed out by Giovanni Federico, *An Economic History of Silk Industry, 1830-1930* (Cambridge: Cambridge University Press, 1997), pp. 14-15.

[20] Brockett, *Silk Industry in America*, pp. 28-29; Marsh, *Georgia´s Frontier Women*, p. 56.

[21] Brockett, *Silk Industry in America*, pp. 28-29; Bonner, 'Silk Growing in the Georgia Colony', p. 147.

[22] Brockett, *The Silk Industry in America*, p. 32.

EEIC to supervise the adoption of Piedmontese silk reeling technology in Bengal.[23] In spite of the support, attempts to innovate silk reeling technologies ultimately failed. The failure attests to the difficulties presented by setting up silk production in new world areas. All these attempts to adopt silk processing technologies in the American colonies also attests to the importance given to supplying the British silk weaving sector with raw silk produced in areas directly or indirectly dependent on the British crown. Both the trading and settler companies followed mercantilist reasoning and made silk production one of the goals of their policies. The British government supported these efforts directly by supplying mulberry trees and silkworms, and more frequently indirectly by exempting raw silk from duties.[24]

## 2.2. The English East India Company's Finance and Bengal Raw Silk after Plassey

The second factor that influenced the EEIC's decision to invest in silk manufacturing was the need to transfer revenues from Bengal through the export of goods. When Lord Clive won the Battle of Plassey (1757) and secured control over Bengal and later the dewany of Bengal, Bihar and Orissa (1765), everyone expected new fortunes for the Company.[25] However, potential revenue needed to be transferred back to England. The transfer of bullion was logistically difficult and bills of exchange could only be used in a limited way. Therefore export trade became the major vehicle for transferring

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[23] Marsh, *Georgia's Frontier Women*, p. 60.

[24] In 1749 an Act was passed through Parliament, which exempted raw silk from Carolina and Georgia from export duties. Ibid., p. 28.

[25] The assumption of the dewany presented the Company with the right to collect land rents, customs duties, farms of exclusive privileges, fines and forfeits. House of Commons, 'Fourth Report of the Secret Committee', *Reports from Committees of the House of Commons*, 1715-1801 (1) IV, 1803, p. 95.

revenues to Europe.[26] In order to achieve this, the Company relied on the expansion in the trade of items called “the choicest goods”: raw silk, raw cotton, textiles, and indigo.

The acquisition of the dewany, or in other words the right to collect land rents, customs duties, exclusive privileges, fines and forfeits, presented the Company with a new source of revenue.[27] It thus altered the financial structure of the Company. It is difficult to assert the extent to which the Company financed its investment into the procurement of export goods from its territorial revenues. However, bullion shipments might be taken as an indicator of the change that took place. The Company traditionally relied on bullion shipments to finance the purchase of goods in Asia. In the period 1708-60, bullion made up to 75 percent of the value of all of the Company’s exports to Asia.[28] By contrast, in the decade 1762-72, it accounted only to 23 percent on average.[29] According to Om Prakash, in the post-1760 period the purchase of piece goods in India and China was financed primarily from the dewany revenues and with bills of exchange.[30] Bills of exchange were “rupee receipts obtained against bills of exchange payable in London or elsewhere” and were used by the Company employees in India to transmit to Europe the fortunes made in private trade.[31] As for the dewany revenues, Om Prakash contends that “it would seem impossible to work out on a systematic basis what proportion of the total exports of the English East India Company in the post-1765

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[26] Huw Bowen, ‘Lord Clive and Speculation in East India Company Stock, 1766’, *Historical Journal* 30 (4), 1987, p. 909.

[27] House of Commons, ‘Fourth Report of the Secret Committee’, p. 95.

[28] Bowen, *Revenue and Reform,* p. 111.

[29] Ibid.

[30] Prakash, ‘English East India Company and India’, in Huw V. Bowen, Margarette Lincoln and Nigel Rigby (eds.), *The Worlds of the English East India Company* (New York: Boydel Press, 2002), pp. 10-12.

[31] Ibid., p. 10.

era would have been financed from the Bengal revenues", though he concludes that "it would have been substantial".[32]

The major change in the system of the EEIC finance was that the Bengal territorial revenues were used for the purchase of export goods. However, what needs to be pointed out is that the Company remained dependent on profits from the export trade because the dewany revenues could not be used as ready money. Huw Bowen and others have argued that expanding the Company's exports to Europe became an essential instrument for transferring the territorial revenue surplus to Britain.[33] The Company workers in India were repeatedly ordered to increase the purchase of exportable goods, particularly raw silk, indigo and textiles as it was claimed that "the Company through this Channel may have the benefit of receiving as a large a proportion of the Bengal Revenues as circumstances will possibly admit of".[34] Huw Bowen goes further by arguing that after 1765 "the financial wellbeing of the Company was balanced on a knife-edge".[35] At home the liabilities to the stockholders were rising due to an increase of dividend payments. Moreover, among the home charges were also interests on home bond debt, charges on East India House and Board of Control, payments on the account of Her Majesty's Troops and establishments and the Company also had liabilities to the government: customs and duty payments.[36] These liabilities

[32] Ibid., p. 12.

[33] Bowen, 'Investment and Empire', p. 189; Anthony Webster, 'The Political Economy of Trade Liberalization: The East India Company Charter Act of 1813', *Economic History Review* 43 (3), 1990, p. 408.

[34] 'The Directors to the President and Council of Bengal, 20 November 1767', as cited in Bowen, 'Lord Clive and Speculation', p. 909.

[35] Bowen, 'Investment and Empire', p. 189.

[36] Bhimrao R. Ambedkar, 'Administration and Finance of the East India Company' (M.A. Thesis: Columbia University, 1915), p. 16, Bowen, 'Investment and Empire', p. 190.

served as a powerful incentive for the EEIC to expand the export trade from Asia to Europe.

The precarious balance of the Company's finances was brought to attention in 1772. Since 1757, when the Company had come in possession of the dewany, it had paid the British Government £400,000 annually. The Company also paid high dividends to its stockholders. These sums were paid on the understanding that the Company's Indian territorial revenues would surpass its costs. Not only were the estimates "unduly optimistic", but the Company also encountered a series of unforeseeable circumstances.[37] Lucy S. Sutherland names among these the increases of military costs due to French aggression and trade depression in Bengal that was exacerbated by the 1769-70 famine, and increases in administrative costs.[38] Among the Company's Indian expenses were charges incurred in collecting tax revenue, military and naval charges, civil, judicial and police charges, investment in public works and interest on bond debt in India.[39] In 1771, over £1 million worth of bills of exchange were drawn in London by the Company servants.[40] Moreover, in the same year the Company lost another £1 million in the tea trade.[41] Combined with a general credit crisis, the Company suddenly became unable to meet its short-term liabilities and defaulted.

[37] Lucy Sutherland, *The East India Company in Eighteenth-Century Politics* (Oxford: Clarendon Press, 1952), p. 225.

[38] Ibid.

[39] Ambedkar, 'Administration and Finance of the East India Company', p. 15.; Richards, 'The Finances of the East India Company in India, c. 1766-1859', *London School of Economics Working Papers* 153 (11), 2011, p. 19. See also: John F. Richards, 'Fiscal States in Mughal and British India', in Bartolomé Yun-Casalilla and Patrick O'Brien (eds.), *The Rise of Fiscal States: A Global History, 1500-1914* (Cambridge: Cambridge University Press, 2012), pp. 410-42.

[40] IOR/E/4/621: 'Mr Wiss, Superintendent of Silk Trade, in Bengal Despatches, 24 November 1772', India Office Records and Private Papers, p. 379.

[41] Ibid. The Company's tea trade in the 1760s-1770s was negatively affected by the competition of the Dutch East India tea smuggled into Britain and by the political changes in North American colonies, mainly the boycott of tea imports.

In response to this crisis, the Company decided to focus on expanding the trade in goods and to decrease its Bengal expenditures: "However, bad and disagreeable as our situation is", the Company said, "it behoves us to take the most eligible Methods to yield the future Supplies and those appear to us to be a reduction of our Civil and Military Experience in India, and the procuring a large and ample Investment in the choicest Piece Goods that the Country of Bengal can produce that are proper for the Europe market, with the largest returns in raw silk that are possible".[42] Among the items whose investment was promoted were indigo, raw cotton, cotton textiles and raw silk. The focus on each of these commodities was underpinned by specific factors. Indigo production was encouraged in response to the market opportunity represented by the loss of colonial supplies from South Carolina in 1780s and by the later interruption of supplies from Saint Domingue in 1791 due to the slave rebellion.[43] Cotton textiles were important for the re-export trade and were exported to the Atlantic and African markets.[44] Raw cotton and opium were used to buy tea in China. The importance of the China trade increased and it became the essential source of profits.[45]

What connects the attempts at enlarging the export in the aforementioned goods is the Company's effort to accommodate their quality to the demands of the export markets. Such steps were often indispensable as Huw Bowen observes "there

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[42] Ibid., pp. 379-80.

[43] J. R. Ward, 'The Industrial Revolution and British Imperialism, 1750-1850', *Economic History Review* 47 (1), 1994, p. 49.

[44] Huw Bowen, *Business of Empire: The East India Company and Imperial Britain, 1756-1833* (Cambridge: Cambridge University Press, 2006), p. 238. The Company's re-export trade in textiles suffered a blow during the American War of Independence.

[45] Ashin Das Gupta, 'India and the Indian Ocean in the Eighteenth Century', in Uma Das Gupta (ed.), *The World of the Indian Ocean Merchant, 1500-1800: Collected Essays of Ashin Das Gupta* (Oxford: Oxford University Press, 2001), p. 214; Michael Greenberg, *British Trade and the Opening of China, 1800-1842* (Cambridge: Cambridge University Press, 1951), pp. 5-17.

was no point in importing commodities into Britain if nobody wished to buy them".[46] In this respect, the most thorough attempt to accommodate quality to the international demand was undertaken in the silk industry.

## 2.3. Bengal Raw Silk as One of the 'Choicest Goods'

The EEIC had high expectations about its venture into the production of raw silk in Bengal. The importance ascribed to the silk industry is summed up by George Williamson, a former employee of the EEIC in Bengal, when he observed that: "the possession of the Dewanny making the company anxious to increase the silk investment in order to get home the surplus revenue…".[47] It was thought that the new method of reeling in Bengal would bring quality improvements to the silk thread that would result in a 25 percent increase in its price on the British market.[48] Such anticipation was facilitated by the outstanding reputation of the Italian methods of reeling that had made the Piedmontese silk the most sought after and the most expensive raw silk on the European markets. Which factors underpinned the Company's decision to invest in the improvement of the quality of the silk thread? In other words, which were the factors that created the perception that Bengal raw silk would be a profitable item of trade?

This chapter argues that the decision of the Company to become a silk manufacturer was influenced by several factors. The Company's expectation for silk to be one of the 'choicest goods' was supported by value of freight-to-sale ratio

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[46] Bowen, 'Business of Empire', p. 236.

[47] Goldsmiths' Library [G.L.], 1775 fol.: George Williamson, *Proposals Humbly Submitted to the Consideration of Court of Directors for Affair of the United Company of Merchants of England Trading to the East Indies: For Improving and Increasing the Manufacture of Silk in Bengal* (London, s.n., 1775), p. 13.

[48] IOR/E/1/61 ff. 486-487v: 'Letter 240 James Wiss in London to the Court Outlining the Advantage of the Italian Method of Spinning Silk in Bengal, 18 November 1777', India Office Records and Private Papers, p. 487.

(percentage of the cost of freight of raw silk). Table 2.1 shows that with a mere 3.7 percent freight-to-sale cost, raw silk was the most profitable commodity per freight unit.[49] Extending the trade in raw silk seemed a reasonable move also because this commodity was already an important part of Bengal's exports. K. N. Chaudhuri's data for the 1750s shows that raw silk represented 9.4 percent of the value of the EEIC's Bengal exports and was the second most important item in the Bengal export trade after cotton cloth.[50] Moreover, the Company's interest was facilitated by the British government's support of the domestic silk weaving industry. As the British silk industry lacked a source of domestic raw silk, and faced the competition of the superior silk production of France, it could only be sustained through protective legislation.[51]

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[49] Although, the data refer to 1800s there is no reason to believe that the proportions were significantly different in the previous decades.

[50] Bengal export of textiles accounted for more than 85% of the total on average. K. N. Chaudhuri, *The Trading World of Asia and the English East India Company, 1660-1760* (Cambridge: Cambridge University Press, 1978), pp. 510 and 534.

[51] Moira Thunder, *Spitalfields Silks: V&A Pattern* (London: V&A Publishing, 2011), p. 4; Donald C. Coleman, *Courtaulds: An Economic and Social History: The Nineteenth Century Silk and Crape* (Oxford: Clarendon Press, 1969), Vol. 1, p. 14; Gail Malmgreen, *Silk Town: Industry and Culture in Macclesfield, 1750-1835* (Hull: Hull University Press, 1985), pp. 8-9.

**Table 2.1. Sale Value and Freight Cost of the English East India Company's Commodities Traded to Britain, March 1804 to September 1808**

| Goods | Sale Value (£) | Freight Cost (£) | Proportion of Freight to Sale Value (%) |
|---|---|---|---|
| Bengal Raw Silk | 1,603,663 | 59,411 | 3.7 |
| Piece Goods | 4,073,587 | 508,400 | 14.2 |
| Spice | 185,279 | 33,326 | 18.0 |
| Cinnamon | 381,822 | 69,893 | 18.0 |
| Drugs, &c. | 665,877 | 315,913 | 47.4 |
| Sugar | 937,648 | 669,123 | 71.4 |
| Salpetre | 900,092 | 650,697 | 72.3 |
| **Total** | 8,747,968 | 2,306,823 | 26.4 |

*Source*: IOR/L/PARL/2/55, 'Supplement to the Fourth Report on the Affairs of the East India Company, Appendix No. 47, 1808-12', p. 138.

The British silk industry was supported by three of the key mercantilist measures named by Adam Smith: the import of silk fabrics was curtailed by prohibitions or duties; the importation of raw silk was encouraged through decreases of import duties; and measures encouraging the export of British silk fabrics were put in place.[52] Never a leader in international markets from the seventeenth to the beginning of the nineteenth century, British silk products were however among the principal export goods of the British Isles. The weaving sector was dependent on imports of raw silk and its consumption was far from trivial. Mitchell's historical statistics show that in the 1750s and 1760s raw silk was quantitatively the most important raw material imported into Britain.[53] This explains why the British government was keen to secure supplies of

[52] Adam Smith, *An Inquiry into the Wealth and Poverty of Nations* (University of Pennsylvania: An Electronics Classics Publication, 2005); Raymond L. Sickinger, 'Regulation or Ruination: Parliament's Consistent Pattern of Mercantilist Regulation of the English Textile Trade, 1660-1800', *Parliamentary History* 19 (2), 2000, pp. 225-28.

[53] B. R. Mitchell, *British Historical Statistics* (Cambridge: Cambridge University Press, 1988), p. 463.

raw silk from colonial settlements by differentiating import duties. As table 2.2 shows, import duties on Bengal raw silk were lower than on the Chinese or Italian raw silk in the periods 1750-65 and 1801-23.

**Table 2.2. Import Duties on Raw Silk and Thrown Silk Imported into Britain, 1704-1823**

| **Year** | | **Raw Silk** | | **Year** | **Thrown Silk** |
|---|---|---|---|---|---|
| | **China** | **Bengal** | **Italy** | | |
| **1704-47** | 2s. 6d. | 1s. 3d. | 11d. | **1704-47** | 3s. 2d. |
| **1747-50** | 3s. 2d. | 1s. 7d. | 1s. 3d. | **1747-65** | 4s. 0d. |
| **1750-65** | 3s. 2d. | 1s 3d. | 1s. 7d. | **1765-79** | 4s. 6d. |
| **1765-79** | 10d. | 10d. | 10d. | **1779-81** | 4s. 9d. |
| **1779-84** | 11d. | 11d. | 11d. | **1781** | 4s. 11d. |
| **1784** | 3s. 0d. | 3s. 0d. | 3s. 0d. | **1782-4** | 5s. 2d. |
| **1797** | 3s. 3d. | 3s. 3d. | 3s. 3d. | **1784** | 7s. 4d. |
| **1801** | 5s. 1d. | 3s. 9d. | 5s. 1d. | **1797** | 8s. 0d. |
| **1807** | 5s. 5d. | 4s. 9d. | 5s. 5d. | **1805** | 11. 5d. |
| **1817-23** | 5s. 6d. | 3s. 6d. | 5s. 6d. | **1807** | 12s. 2d. |

Source: D. C. Coleman, *Courtaulds: An Economic and Social History, The Nineteenth Century Silk and Crape* (Oxford: Clarendon Press, 1969),Vol. 1, pp. 18-19.

A further factor affected the Company's intra-Indian trade. Huw Bowen has pointed to the fact that the second half of the eighteenth century saw a significant expansion of the intra-Asian trade.[54] The expansion of the so-called 'country trade' served the financial and commercial needs of the Company. Instead of importing bullion in order to pay for goods destined to the European market, the EEIC procured these export goods in exchange for Asian goods demanded in particular Asian markets. The best-known example of the intra-Asian trade is the imports of opium and raw

[54] Huw V. Bowen, 'British Export of Raw Cotton from India to China during the Late Eighteenth and Early Nineteenth Century', in Giorgio Riello and Tirthankar Roy (eds.), *How India Clothed the World: The World of South Asian Textiles, 1500-1850* (Leiden: Brill, 2009), pp. 115-17.

cotton from India into China in exchange for tea.[55] The EEIC therefore used Bengal raw silk in the intra-Indian trade in order to supply Bengal with raw cotton; "a sufficient quantity remain to supply the trade in India, and thereby to procure cotton for the province of Bengal, without exporting your specie for that Raw material".[56] However, it was not only the total quantity of raw material that the Company needed to increase. In 1778 James Wiss reported to London that since the import of Chinese raw silk had been allowed into the Bombay market three years earlier, Bengal raw silk lost its ground "on Account of their bad quality and of the difficulty of winding them".[57] He encouraged the Company to prohibit the trade in raw silk between China and Bombay. He added that only Bengal raw silk sent to Bombay and reeled in the Italian method would have found a market there. Thus, improvements in the quality of Bengal raw silk were

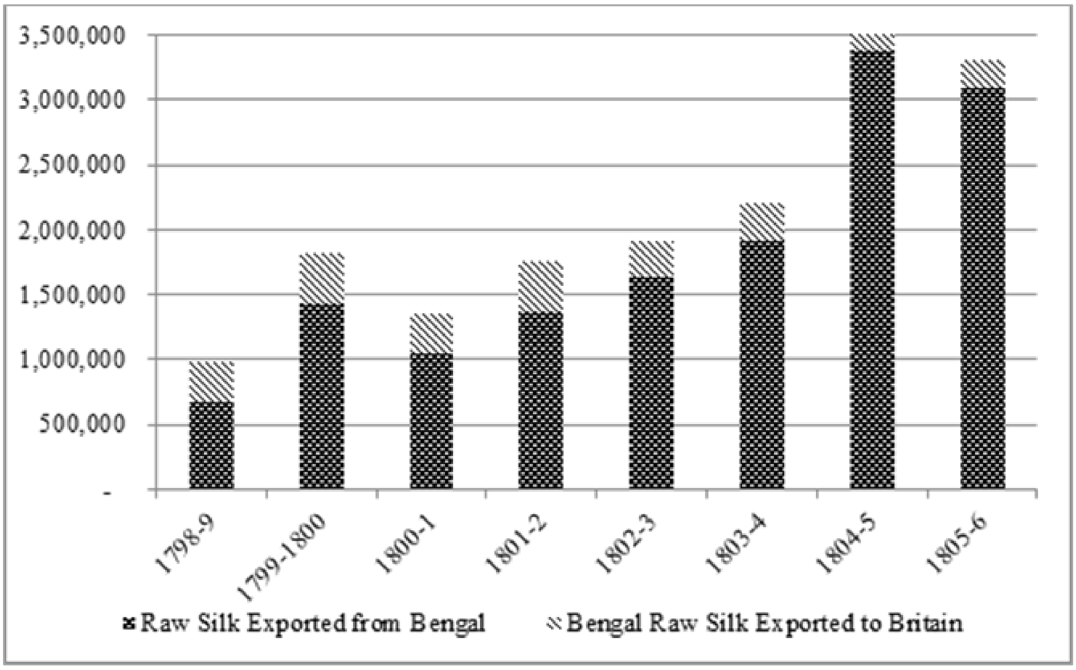
[55] Bengal raw silk was exported mainly to the Malabar Coast and Coromandel. The value of Bengal raw silk traded there in 1805 was 2,055,594 sicca rupees (£222,689). When compared with data from Figure 2.1, it means that less than 10% of the whole production of raw silk in Bengal was exported to Malabar and Coromandel Coasts. However, data by William Milburn might not be totally reliable as in many cases they do not match the Company's statistics. The important information produced by Milburn is the geographical distribution of trade rather than its quantities. William Milburn, *Oriental Commerce* (London: Black, Perry & Co., 1813), Vol. 2, pp. 138-39. For country-trade see: Das Gupta, 'India and the Indian Ocean in the Eighteenth Century', pp. 188-225; Greenberg, *British Trade and the Opening of China*, pp. 75-103.

[56] IOR/E/4/623: 'Silk, Growth of Mulberry Plantations Encouraged, 24 December, 1776', India Office Records and Private Papers, p. 284.

[57] IOR/E/1/63 ff. 19-20v: 'Letter 8 Report of James Wiss to the Committee of Correspondence on the Silk Trade in India, London 14 July 1778', India Office Records and Private Papers, p. 19. James Wiss was one of the silk specialists contracted by the EEIC to implement the Piedmontese system of reeling in Bengal. Wiss was sent to Bengal in 1769 and worked for the Company in Bengal until 1777. Wiss's real name was Giacomo and he came from Novi in Italy; his knowledge of silk production and English made him a very valuable servant and Wiss became instrumental in silk manufacturing in Bengal. Due to his abilities, Wiss was appointed Inspector of the Bengal raw silk in London in 1777 and "continued in the Company's home service for many years". LSE Archives, W7204, East India Company. *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London, J.L. Cox, 1836), p. xvii; IOR/E/4/625, 9 April 1777, p. 171.

important also for the Company's intra-Asian trade. This is apparent when the value of the exports of raw silk from Bengal is compared to the value of the exports of Bengal raw silk to Britain (Figure 2.1).

**Figure 2.1. Value of Raw Silk Exported from Bengal, 1798-1806**




*Source*: Compiled from L/PARL/2/55: 'Appendix to the First Report of the Select Committee on the Affairs of the East India Company', p. 60, 'Appendix to the Fourth Report of the Select Committee on the Affairs of the East India Company', p. 230.

These factors show that the Company's interest in producing raw silk had a strong footing. The question that arises is whether the trade data for 1770s to 1810s confirms the Company's expectations. For this purpose, I consider the role of the trade in Bengal raw silk in the Company's Euro-Asian trade. The EEIC trade data for the period 1793 to 1812 shows that raw silk accounted on average for 6.8 percent of the Company's total sales of Indian and Chinese goods in Europe. For Bengal raw silk, the Company's data is available only for the period 1793-1807, when it accounted on average 4.7 percent of total sales. However, this figure is not necessarily representative of the actual importance of raw silk, as it needs to be understood in connection to the emergence of tea as a key trade commodity. In the late eighteenth century, the China tea trade became an essential source of profit as well as a tool for remitting Indian revenues. The growth of the tea trade was driven by two factors. First, it was facilitated by an increase in the demand for tea in Britain. Imports of tea from China were boosted by the 1784 Pitt's Commutation Act which decreased the import duty on tea from 119 percent to a mere 12.5 percent.[58] Second, demand for tea increased also in other parts of Europe and the Atlantic world driving the expansion of tea trade.[59] For these reasons, the share of tea exceeded 50 percent in this period of the Company's sales. However, when silk is compared to the sales of other items, its role becomes more apparent. Table 2.3 shows that raw silk was the third most important export product on the London market. Approximately 81 percent of the value of raw silk imported to London in the period 1799-1806 came from Bengal.[60]

[58] Moreover, the increase in demand was associated with the expansion of British manufacturing, as the growth of tea trade was facilitated by the increased consumption of tea by the urban working-class. Huw Bowen, 'Sinews of Trade and Empire: The Study of Commodity Exports to the East India Company during the Late Eighteenth Century', *Economic History Review* 55 (3), 2002, p. 469; Ward, 'The Industrial Revolution and British Imperialism', pp. 53-55; Amanda Vickery shows that also servants were consuming tea and were given an allowance of tea in the eighteenth century. Amanda Vickery, *The Gentleman's Daughter: Women Lives in Georgian England* (London: Yale University Press, 1998), pp. 27, 142, 222 and 207-8.

[59] Bowen, 'British Export of Raw Cotton', p. 118.

[60] The average annual value of the Company's exports of raw silk to London in the period 1799-1806 amounted to £406,560 and approximately £329,635 were from Bengal. L/PARL/2/55: 'Appendix to the First Report of the Select Committee on the Affairs of the East India Company', p. 60, L/PARL/2/55: 'Appendix to the Fourth Report of the Select Committee on the Affairs of the East India Company', p. 230; L/PARL/2/55: 'Appendix, No. 24 to the IV Report of the Select Committee on the Affairs of the East India Company', pp. 492-93.

**Table 2.3. Value of the London Sales of the English East India Company's Goods, 1793-1810**

| Goods | Total Sales (in £) | Average Annual Sales (in £) | Share (%) of Goods on Average Annual Sales |
|---|---|---|---|
| Tea | 55,160,230 | 3,064,457 | 53.5 |
| Piece Goods | 26,054,301 | 1,447,461 | 25.3 |
| Raw Silk | 7,014,986 | 389,721 | 6.8 |
| Pepper | 3,322,835 | 184,602 | 3.2 |
| Saltpetre | 3,060,956 | 170,053 | 3.0 |
| Spices | 1,974,099 | 109,672 | 1.9 |
| Drugs, Sugar, Indigo, etc. | 5,031,516 | 279,529 | 4.9 |
| Other Goods | 8,415,292 | 467,516 | 8.2 |
| **Total** | 110,034,215 | 6,113,011 | 100 |

*Source*: Compiled from L/PARL/2/55: 'Appendix, No. 24 to the IV Report of the Select Committee on the Affairs of the East India Company', pp. 492-93.

Drugs, especially opium, sugar and indigo were the only other items besides raw silk that the EEIC attempted to manufacture under its direct control in India. The Company referred to sugar, indigo, and coffee as 'new articles' of trade and attempted to expand their trade as it did with Bengal raw silk. However the EEIC's venture into the manufacturing of these goods was never as extensive as the Company's involvement in the silk industry. The Company' engagement in the 'new articles' was mostly limited to experimentation and the Company's effort never translated "into extensive sales of [such] new commodities in London".[61] On the other hand, the officially sanctioned private trade in these articles was extensive.[62] This leads us to the conclusion that private traders were more successful than the Company in procuring new trade items such as sugar, indigo or coffee but failed to procure raw silk.

[61] Bowen, *Business of Empire,* p. 245.

[62] Ibid.

## 2.4. Mercantilism and the English East India Company's Commitment to Raw Silk Production in Bengal

It is indisputable that the EEIC's engagement in the Bengal silk industry was principally motivated by profits. However, I argue that mercantilist principles played an important part in facilitating the Company's commitment to invest in raw silk production. During its rule over India, the EEIC was involved in several projects entailing production processes. A number of reports detailing the efforts undertaken by the Company in cultivating raw silk, raw cotton, indigo, sugar and opium survive.[63] Similarly, the Company ventured into cotton textiles production.[64] Claudio Zanier has argued that these ventures were a mere extension of the Company's commercial activities guided by short-term financial gains. My aim is to show that the EEIC's investment in Bengal raw silk production was guided by factors other than mere short-term returns.

Mercantilism was a "practical political economy policy" of the seventeenth and eighteenth century, which focussed on solving the question of "how to achieve national wealth and power".[65] Mercantilism never became a doctrine with strictly defined principles.[66] Nevertheless, it is usually stated that the prevention of out-flow of bullion, a positive balance of payments and the promotion of employment were among the prime concerns of mercantilist theories. Similar conclusions can be reached through the

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[63] Another attempt to promote silk production was carried out on the Coromandel Coast. However this project did not succeed. Maxine Berg, 'Passionate Projectors: Savants and Silk on the Coromandel Coast 1780-1798', *Journal of Colonialism and Colonial History* 14 (3), 2013, pp. 18-19.

[64] LSE Archives, W7204, East India Company. *Reports and Documents;* East India Company. *Debate on the Expediency of Cultivating Sugar in the Territories of the East India Company* (London: Reporter, 1793); East India Company, *Report of the Select Committee of the Court of Directors upon the Cotton of This Country: With Appendixes* (London: n. p., 1793).

[65] Lars Magnusson, 'Introduction', in Lars Magnusson (ed.), *Mercantilism: Critical Concepts in the History of Economics* (London: Routledge, 1995), Vol. 1, p. 4.

[66] Ibid., p. 6; Donald C. Coleman, 'Mercantilism Revisited', *Historical Journal* 23 (4), 1980, pp. 773-91.

analysis of contemporary pamphlets and treatises. Most of the texts published by seventeenth- and eighteenth-century economic writers deal with practical questions of how to expand trade, improve the balance of trade, increase production and the employment of the poor.[67] Ideas differ significantly especially about the level of trade protectionisms and to the role of the East India Company. However, when we look at mercantilist writings concerning the British silk industry, a certain level of consensus emerges. First, there was general agreement that the silk industry should be protected by the Government through an import ban on finished silk textiles. Second, raw silk should be imported from colonies rather than from other European countries because European countries were considered trade competitors.[68] From this point of view, the EEIC's plan to import silk from Bengal was considered favourably.

J. Thorp, a contemporary writer, even considered the Company's efforts in improving the quality of Bengal raw silk as insufficient and urged for more attention to the issue.[69] These principles illustrate the contemporary thought about the production of raw materials in non-territorial settlements for their use in British manufacturing. In the case of the silk industry, mercantilist principles are usually assumed to correspond with import substitution policies. In Britain, the import of finished silks was restricted with the aim of substituting these imported cloths with domestic production. The prevention of outflow of bullion, threat of riots and idleness of workers were embedded in import-

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[67] For the collection of significant mercantilist writers see: Lars Magnusson (ed.), *Mercantilism: Critical Concepts*, Vols. 1-4.

[68] See for instance: J. Thorp, *Considerations on the Present State of the Cotton and Silk Manufactories of Great Britain: And the Impropriety of Continuing to Draw the Supply of Materials for the Latter from France and Italy* (London: Lane, Darling and Co, 1807), pp. 10-13, 15-17; Joshua Gee, *The Trade and Navigation of Great-Britain Considered: Shewing, that the Surest Way for a Nation to Increase in Riches, Is to Prevent the Importation of Such Foreign Commodities as May Be Raised at Home* (London: Sam Buckley, 1729), pp. 1-23.

[69] Thorp, *Considerations*, pp. 16-17.

substitution policies.[70] Already in 1689, Josiah Child argued that through the importation of inputs for the domestic industry, foreign trade stimulated the national growth of employment and manufacturing.[71] In the eighteenth century, Joshua Gee claimed that it was of national importance to engage in plantation cultivation due to "the Profits of our Plantations may yield us, by raising Hemp, Flax, Silk, Iron, Po-ash, & c.".[72] Gee also argued that the promotion of trade, manufactures and colonies was essential for increasing the wealth of the nation.[73] He dedicated several pages of his treatise to the trade in raw silk and argued for the necessity of importing cheap raw silk from Asia and promoting the cultivation of silk in the British colonies.[74]

The perception that extraterritorial settlements should be used as a source of raw materials for British manufacturers was widely accepted also by the EEIC. Such thinking seems to permeate the Company's policies in Bengal, especially in respect to the venture into the silk industry. The Company's correspondence in 1770s and 1780s shows a great deal of commitment to the implementation of the Italian method of reeling. The records of the Company illustrate the faith in the success of the venture and the possible returns on this investment. Raw silk was labelled as a "valuable item of trade" and servants were ordered to keep investing into raw silk even during the

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[70] David Omrod, *The Rise of Empires: England and the Netherlands in the Age of Mercantilism, 1650-1770* (Cambridge: Cambridge University Press, 2003), p. 168; Harky G. Johnson, 'Mercantilism: Past, Present and Future', *The Manchester School* 42 (1), 1974, p. 3.

[71] Josiah Child, *A Supplement to a Former Treatise Concerning the East-India Trade* (London: n. p., 1689), p. 12; Thomas Papillon, *A Treatise Concerning the East-India Trade: Being a Most Profitable Trade to the Kingdom, and Best Secured and Improved by a Company and a Joint-Stock* (London: n.p., 1680), p. 3.

[72] Gee, *The Trade and Navigation of Great-Britain*, p. v.

[73] Ibid., pp. 2-23.

[74] Ibid., pp. 43-44, and 87-92.

Company's financial difficulties in 1772.[75] This attitude was underpinned by the expectation that the production of 'Bengal Italian raw silk' would bring profits to the Company. Furthermore, mercantilist principles played a key role. The Company considered the export of Bengal raw silk to be beneficial also to British manufacturers and the investment at large:

> It is in the increase of this Article of Our Investment that we chiefly depend for the bringing home our Revenues; the Importation being a national benefit and the Consumption more unlimited than that of the Manufactured Goods. You must therefore continue to bestow the greatest attention to it.[76]

It was the trade in raw silk that the Company attempted to use to make its trading activities more appealing to the mercantilist state.[77] The Company especially drew on the mercantilist objective of securing raw material imports without the necessity of depending on foreign countries. The EEIC emphasized that the production of 'Bengal Italian raw silk' would allow the British silk industry to decrease its dependence on the imports of Italian raw silk. This is why the Company underlined the import substitution policy as underpinning the strategic importance of its Bengal project.[78] The same argument was present also in the letters sent from London to Bengal, in which it was pointed out that the Company was "desirous to promote by all possible means the increase and improvement of your Investment of Raw Silk as an object equally

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[75] IOR/E/4/621: 'Bengal Despatches, 24 November 1772', p. 380; IOR/E/4/619: 'Cultivation of Mulberry, 17 March 1769', p. 333; IOR/E/4/625: 'Silk, Italian Method of Spinning and Winding Introduced into India by Mr Wiss, 9 April 1779', India Office Records and Private Papers, p. 133; IOR/E/4/621: 'Mr Wiss, Superintendent of Silk Trade', p. 379.

[76] IOR/E/4/618, 16 March 1768, p. 919.

[77] Edmund Burke, *The Works of the Right Honourable Edmund Burke* (Boston: Wells and Lilly, 1826), Vol. 6, p. 68.

[78] In general the rationales of import-substitution policies in the pre-industrial Europe were prevention of outflow of bullion, threat of riots and idleness of workers, David Omrod, *Rise of Empires*, p. 168; Johnson, 'Mercantilism: Past, Present and Future', p. 3.

beneficial to the Nation and the Company".[79] The pressure from London on extending the cultivation of mulberries was apparent: "your attention to their cultivation will most essentially promote the Interest of the Company, and of the Nation, Raw Silk, and especially Filature Silk being a very beneficial article of our imports, and of great consequence to our manufactures of Britain".[80] The Company considered Bengal raw silk "an article of such national consequence" and assigned its improvement great importance.[81] The Company drew on the mercantilist ideas and maintained the aim of achieving independence from the imports of raw materials from foreign countries.

Similarly, the Company applied mercantilist thinking in the administration of Bengal. The Court of Directors claimed that it was necessary for the Company to change its policies after the Battle of Plassey and that "it became necessary to adopt measures more consonant with the improved situation of their affairs. The Company were now become the rulers of a valuable, extensive and fertile country, producing, in ordinary periods, revenues more than equal to the current expenses of its management."[82] The Company relied on mercantilist principles in administering Bengal – it principally sought efficient use of the Bengal resources and promoted employment. Silk was deemed by the Company as the item of trade most suitable for expansion due "first, as affording to the means for extended cultivation, and next, by creating additional employment for the natives: two objects that ought never be lost sight of in

[79] IOR/E/4/619: 'Richard Wilder, Bengal Raw Silk, 17 March 1769', India Office Records and Private Papers, p. 339.

[80] IOR/E/4/623: 'Silk, Growth of Mulberry Plantations Encouraged', p. 286.

[81] IOR/E/4/621: 'Bengal Despatches, 7 April 1773', India Office Records and Private Papers, p. 471.

[82] Goldsmiths' Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London, n.p., 1795), pp. 13-14.

all well-regulated states”.[83] The Company sought to prevent the idleness of workers, a condition typically despised by mercantilists.

Yet the EEIC never lost profits from its sight. The Company ventured into Bengal silk production because it expected that once Piedmontese methods of reeling were implemented, the trade in Bengal raw silk would bring profits. The Company’s goal was not to promote the industry for the sake of the development of Bengal. Hence, in the periods when raw silk production proved to be an unprofitable venture, the Company scaled down its investment and focussed on recovering the costs incurred. Such a situation occurred for instance in the 1790s when the British market became overstocked.

I argue that it was the combination of factors that made Bengal raw silk a potentially profitable item of trade. Mercantilist thinking made the EEIC invest into the venture for much longer than an investment policy based on short-term decisions would suggest. It is true that after 1785 the EEIC did not embark on any new projects of technology transfer; however the Company did not cease its investment either. The EEIC continued to produce raw silk in its several filatures until 1830s, when the filatures were sold to private manufacturers in accordance to the 1833 Charter that revoked the Company’s right to carry out any economic activities.[84] The Company’s understanding that further improvement to the quality of the Bengal raw silk was essential for “retrieving the heavy sums which have been sunk in bringing this article to

[83] Ibid., pp. 13-14. This view was taken also by William Milburn in the beginning of the nineteenth century. Milburn maintained that raw silk “appeared the most eligible for the interests of that country [Bengal]; first, as affording the means for extending cultivation; and, secondly, by creating additional employment for the natives”. Milburn, *Oriental Commerce*, pp. 252.

[84] Claudio Zanier, ‘Silk Culture in Western India: The ‘Mutti Experiment’, 1830-47’, *Indian Economic and Social History Review* 21 (4), 1984, pp. 463-64.

its present state of perfection” suggests that the sunk costs compelled the Company to continue in this venture until 1830s.[85]

## 2.5. Conclusion

The EEIC’s venture into Bengal silk manufacturing was not an isolated experiment but needs to be considered along with the other initiatives focussed on extending raw silk production in British colonial settlements. Beside Bengal, attempts were made to produce raw silk in several North American colonies. Such plans were guided by the mercantilist objective of securing supplies of raw materials from dependent territories. However, with the exception of Bengal, none of these initiatives was successful in bringing raw silk to the British market.

I have shown that the Company’s venture into silk manufacturing in Bengal was underpinned by five factors. First, the importation of Bengal raw silk was supported by low duties. Second, raw silk was quantitatively the most important raw material imported into Britain in the 1750s and 1760s.[86] Third, Bengal raw silk was the Company’s second most important Bengal export item. Fourth, the proportion of freight-to-sale amount was the lowest for raw silk. Finally, Bengal raw silk was used in the Indian trade to procure raw cotton and other items for Bengal. All these factors made the plan to extend the trade in raw silk a rational decision on the part of the Company.

Apart from these factors, investment into raw silk production was also facilitated by the mercantilist principles of the EEIC. The Company’s economic thinking was permeated by mercantilist rationales. The rhetoric of promotion of national interests was used not only in communicating with British manufacturers but also in the

[85] L/PARL/2/55: ‘Appendix to the Fourth Report’, p. 217.

[86] Mitchell, *British Historical Statistics*, p. 463.

correspondence with the Company's Bengal factors. The Company perceived the venture into the Bengal silk industry as a project of national importance – which was meant to support silk manufacturing in Britain – as much as an investment project supposed to generate profits.

# CHAPTER 3

## The Bengal Silk Enterprise and Knowledge Transfer

> To prevent these Defects, as well as to shorten the labour and lessen the Expense of so many successive operations as the silk passes through to the state in which we receive it, the most eligible improvement would be to have it wound of at once from the Cocoons into skeins of such quality and Dimensions as may fit it for the European Markets after the manner of China and Italian Raw Silk.[1]

In the 1770s the EEIC decided to engage in knowledge transfer and implement the Piedmontese system for the reeling of silk in Bengal. The central focus of the project was to improve the quality of raw silk. The aim was to produce what the Company called 'Bengal Italian raw silk' – Bengal-made raw silk of the same quality as the highly sought-after Italian silk. This would have allowed to reduce the importation of raw silk from Italy.[2] The chapter argues that the choice of a centralized and vertically integrated system of reeling as practiced in Piedmont was essential for the success of the transfer. This reflects the argument put forward by Joel Mokyr that high costs of moving information were key to the emergence of centralized factories.[3] However, all of the

[1] IOR/E/4/619: 'Bengal Despatches', India Office Records and Private Papers, 17 March 1769, p. 336.

[2] 'Bengal Italian Raw Silk' was a term used by the Company in reference to the filature-made raw silk. For example, IOR/E/1/65 ff. 440-441v: 'Letter 270 James Wiss in London to the Court Recommending the Appointment of Three Superintendents for the Raw Silk Filature in Bengal', 20 December 1779, pp. 440-41.

[3] Joel Mokyr argues that the emergence of the factory system was propelled by the development of technology and by the growth of the pool of knowledge. Technological progress made concentration of workers in centralized factories necessary because the new production processes "required a level of competence that was beyond the capability of the individual household". Meanwhile, instructing,

benefits of vertical integration and centralization were not realized because the EEIC did not innovate its management practices and the incentives provided to the Company's servants in Bengal were incompatible with the production of high-quality silk.

## 3.1. Knowledge Transmission and the Bengal Silk Industry

By the 1750s, the EEIC was aware that without an improvement in quality, Bengal raw silk would not increase its share of the raw silk market in Britain. Spurred by the mounting dissatisfaction of British silk weavers with the quality of Bengal raw silk and encouraged by the assumption that the "Piedmontese technology [had] a universal capacity to upgrade local production", the EEIC decided to rely on knowledge and technologies from Europe to alter the method of reeling Bengal raw silk.[4]

The introduction of the Piedmontese method of reeling required a change of strategy for the EEIC. The previous attempts of the EEIC to implement changes to the reeling practices had failed as even minute changes turned out to be unenforceable under the existing putting-out system. In contrast, the Piedmontese system required centralization of production to secure a high-quality product. This chapter supports the proposition made by institutional economists that 'organization matters': vertical integration made knowledge transmission possible by decreasing its cost and by

supervising and coordinating workers at a domestic level would have been too costly. Thus, once best-practice techniques became too complex, firms became the mechanisms of knowledge transmission. Hence, Mokyr argues that it was the relative costs of moving information about the best-practice techniques versus the costs of moving workers into factories that facilitated the factory system. Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton: Princeton University Press, 2002), pp. 120 and 141-45.

[4] Roberto Davini, 'A Global Supremacy: The Worldwide Hegemony of the Piedmontese Reeling Technologies, 1720s-1830s', in Anna Guagnini and Luca Molà (eds.) *History of Technology,* Vol. 32 (London: Bloomsbury Publishing, 2014), pp. 90-91.

creating a hierarchical organizational structure in which the application of new method of reeling could be enforced.[5]

By choosing the Piedmontese system of reeling, the Company opted for a complex system of production. Its implementation necessitated a host of changes: setting up silk filatures; training the Bengalese workforce in the new method; changes in the organization of labour in silk reeling; and changes in procurement. The new system of organization of labour, which followed the adoption of the Piedmontese reeling technology, allowed changes to the reeling system to be implemented. However, the Company did not introduce a factory system with the intention of economizing on transaction costs as assumed by organizational theory.[6] Neither was the filature system adopted with the aim to reduce the costs of instructing reelers in the new method as Joel Mokyr's theory might suggest. According to Mokyr, the factory system emerged when the costs of moving workers into factories sank below the costs of moving information about new practices and methods to workers.[7] The only reason why the EEIC decided to implement the Piedmontese system was to achieve a high-quality end product.

Production in a centrally organized filature proved necessary if changes to reeling practices were to be successfully implemented. The Company attempted to

[5] Oliver E. Williamson, 'The Theory of the Firm as Governance Structure: From Choice to Contract', *Journal of Economic Perspectives* 16 (3), 2002, p. 171. See also: Id., 'The Vertical Integration of Production: Market Failure Considerations', *American Economic Review* 61 (2), 1971, pp. 112-23; Id., 'Transaction Cost Economics: The Governance of Contractual Relations, *Journal of Law and Economics* 22 (2), 1979, pp. 233-61; Id., 'The Economics of Organization: The Transaction Cost Approach', *American Journal of Sociology* 87 (3), 1981, pp. 548-77. Organization was also studied by institutional economists such as: Thorstein Veblen, *The Theory of Business Enterprise* (New York: Charles Scribner´s Sons, 1904); John R. Commons, *Institutional Economics* (Madison: University of Wisconsin Press, 1934); and Ronald Coase 'The Nature of Firm', *Economica*, 4 (16), 1937, pp. 386-405.

[6] Oliver E. Williamson, 'The Organization of Work: A Comparative Institutional Assessment', *Journal of Economic Behaviour & Organization* 1 (1), 1980, pp. 11-12.

[7] Mokyr, *Gifts of Athena*, p. 120.

adopt changes to the reeling method in the 1750s but did not succeed. In what was a putting-out system, the reelers refused to implement new practices fearing that these would reduce the speed of reeling and therefore the quantities of reeled yarn produced.[8] In contrast to the previous putting-out system, in filatures reelers did not bear the full cost of learning and became willing to implement the new method of reeling.

A key element of the Piedmontese reeling system was the building of the silk filatures. Filatures were factory-like establishments whose construction represented an important turning towards a centralised system of production.[9] Filatures were characterized by the supervision of reelers, inflexible discipline and managerial hierarchy. Reeling silk in filatures was meant to ensure the high quality of reeling as well as the efficiency of reelers.[10] In Bengal, however, the construction of filatures had other aims aside from quality enforcement. They were crucial for transmitting knowledge of the Piedmontese reeling system. Filatures enabled one foreign silk specialist to instruct a number of Bengalese reelers at the same time and to supervise them in the initial stages of learning the new method.

The successful implementation of the Piedmontese filature system in Bengal supports Mokyr's argument that the emergence of the factory system was driven by the relative costs and benefits of moving people versus moving information.[11] First, the Bengalese reelers had to be instructed in a new reeling method. Setting up centralized

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[8] IOR/G/23/13: 'Factory Records: Kasimbazar, 1757-59', India Office Records and Private Papers, 7 October 1758, p. 108.

[9] Filatures in Bengal were bigger than in Piedmont. The materials used for building of filatures were bricks and wood such as bamboo, teak, malaca etc. It was necessary to use materials which were able to survive in the monsoon climate. Roberto Davini, 'Una Conquista Incerta: La Compagnia Inglese delle Indie e la Seta del Bengala, 1769-1833' (Unpublished PhD thesis: European University Institute, 2004), pp. 230-32 and 247.

[10] IOR/G/23/13: 'Factory Records: Kasimbazar, 1757-59', p. 15.

[11] Mokyr, *Gifts of Athena*, pp. 120-22.

plants reduced the costs of disseminating the new practice by making it possible to train multiple reelers at the same time. The presence of an experienced silk specialist familiar with the method was essential as the technique was not formally codified. Demonstration was also indispensable to overcome the language barrier between the foreign silk specialists who spoke Italian/French and/or English and the local workforce.

Second, the successful implementation of the Piedmontese method of reeling hinged on the adoption of the Piedmontese reeling machine, a considerable capital investment, which made a putting-out system impossible. However, it was not only the cost of the technology that caused a change in the organization of labour. The cost of maintaining the reeling machine was equally important. Maintenance necessitated specialized knowledge and each filature needed specially trained mechanics to carry out maintenance and to repair the machines. The Company had to employ expert mechanics from Europe familiar with the reeling machine to transmit this knowledge.[12] This supports the argument that factory establishments emerged because maintenance of complex machinery required expert knowledge that, in general, was not available at the household level of production.[13]

In the literature, the emergence of factories is often linked to the need to tackle principal-agent problems more efficiently than through contracts. Rachel E. Kranton and Anand V. Swamy, for instance, argued that vertically-integrated firm would enable the EEIC to overcome problems related to the opportunistic behaviour of contractors.[14] Such agency problems draw on incomplete contracting, one of the points of departure of

[12] IOR/E/4/620, 23 March 1770, p. 33. For problems with the maintenance of the reeling machine see IOR/E/4/628, 11 April 1785, pp. 559-61.

[13] Mokyr, *Gifts of Athena*, p. 141.

[14] Rachel E. Kranton and Anand V. Swamy, 'Contracts, Hold-up, and Exports: Textiles and Opium in Colonial India', *American Economic Review* 98 (3), 2008, pp. 968 and 980.

organizational theories which explain the emergence of firms through transaction costs.[15] Vertical integration is supposed to reduce these costs. For example, the emergence of a factory is supposed to align the incentives of agents to the goals of principals and in this way reduce uncertainty and opportunistic behaviour. In this sense it could be expected that the establishment of silk filatures was designed to tackle the principal-agent problems that the Company experienced.

The EEIC often faced the fraudulent behaviour of silk reelers who had the incentive to favour quantity over the quality of production, because the imperfect system of quality control enabled them to pass off low-quality raw silk as silk of a higher quality. The same incentive also applied to gomastas who were contracted by the EEIC to procure raw silk and were in theory supposed to oversee the reelers and supply the Company with the demanded quality and quantity of raw silk. However, as often happened, musters of raw silk - according to which prices were set - exceeded the quality of the delivered silk. This deceitful behaviour of the Company's contractors apparently confirms the conclusion that by setting up silk filatures the Company was attempting to reduce the possibilities of opportunistic behaviour on the part of its agents.

However, contrary to this expectation, the Company's correspondence contains no evidence that the implementation of silk filatures was aimed at surpassing principal-agent problems in procurement. Letters from London giving directions to the Board of Trade in Bengal never mentioned any intention of the Company to limit fraudulent

[15] For incomplete contracting see: Sanford J. Grossman and Oliver D. Hart, 'The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration', *Journal of Political Economy*, 94 (4), 1986, pp. 691-719; and Oliver D. Hart and John Moore, 'Property Rights and the Nature of the Firm', *Journal of Political Economy* 98 (6), 1990, pp. 1119-158. Theories on the emergence of firms based on organizational theory were pioneered by Ronald Coase and Oliver Williamson. Coase, 'The Nature of Firm', pp. 386-405; Oliver E. Williamson, 'The Theory of Firm as a Governance Structure: From Choice to Contract', *Journal of Economic Perspectives* 16 (3), 2002, pp. 171-95.

behaviour. On the contrary, it was deemed by the Court in London that "an Investment by Contract appears to Us, all circumstances considered, the cheapest, the most certain, and the least subject to loss, as not being liable to outstanding Balances".[16] The Court perceived the essential problem to be the fact that investment by contract "precludes, or at least diminishes, the opportunities of improving the Manufactures themselves".[17] This shows that the EEIC established filatures with the sole purpose of improving the quality of raw silk and instructing reelers in the new method rather than to tackle principal-agent problems.

## 3.2. Setting Up Silk Filatures in Bengal

The Company had to send the equipment for setting up the filatures, to contract silk specialists from Piedmont to supervise the building of the filatures in Bengal, and to retrain silk reelers. This explains why the EEIC became directly involved in reeling silk and set up what I call 'the Bengal Silk Enterprise'. I use this label because the EEIC became a producer of goods. Bengal silk production was the only case in which the Company became directly involved in production over the long eighteenth century. In 1769 the EEIC introduced Piedmontese reeling technologies, specifically the system of reeling practiced in Novi.[18] For this purpose the Company sent three silk specialists to Bengal – James Wiss, Pickering Robinson and William Aubert – to become superintendents of the Company's silk investment in Bengal and to set up silk

[16] IOR/E/4/630, 12 April 1786, p. 272.

[17] Ibid., p. 272.

[18] LSE Archives, W7204, East India Company, *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London: J.L. Cox, 1836); Goldsmiths´ Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London, n.p., 1795), p. xi.

filatures.[19] Each of the superintendents was accompanied by reelers or mechanics to assist with training the Bengalese workforce in the Piedmontese reeling technology. These silk specialists were contracted by the EEIC on the recommendation of the silk superintendents.[20]

The superintendents were first to be stationed in Puddapar, Bauleah, and Rungpore, the principal silk aurungs of Kasimbazar (Figure 3.1).[21] Once silk filatures were established in their respective aurungs, they were to move to other silk aurungs "in order to encourage a spirit of emulation [so] that the method of spinning and drawing the silk as practiced at Novi […] should be entirely adopted throughout the whole Country".[22] It was never the intention of the Company to rely on the contracted silk specialists indefinitely, but only until filatures were built across Bengal and the Company's servants were capable of overseeing themselves the production of filature silk. The Court in London repeatedly stated they wished "to see some of our Junior Servants initiated to render them perfectly capable of improving the quality of a chapter of such national consequence".[23]

[19] IOR/E/4/619, 31 January 1770, pp. 655-56.

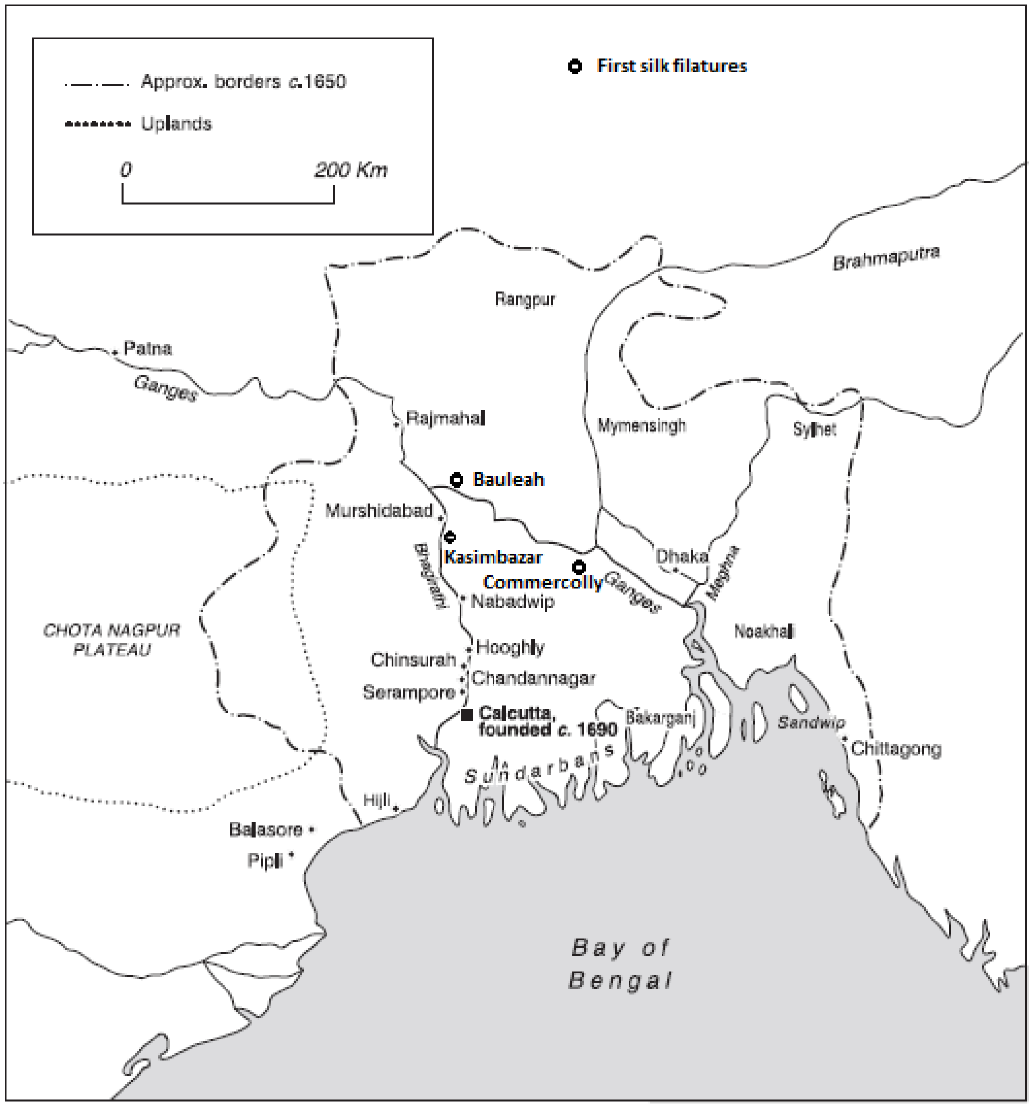
[20] James Wiss, a resident of Piedmont, was accompanied by four Italian reelers (J. Rugiero, Dominicus, C. P. Bricola and Augustus Della Casa). Pickering Robinson, an Englishman who already had experience with transferring the Piedmontese reeling method to Georgia, was accompanied by three Italians (Francis Clerici, Pielo [sic] Spera and Paulo [sic] Erva). William Aubert was accompanied by three reelers from Languedoc (Anthony Broche, Anthony Burgnier and John Peter Angoia) and by the mechanic James Demarin. LSE Archives, W7204, *Reports and Documents,* pp. xi.

[21] IOR/E/4/619, 31 January 1770, p. 658.

[22] IOR/E/4/620, 23 March 1770, p. 28.

[23] IOR/E/4/621, 7 April 1773, p. 471.

**Figure 3.1. Map of Bengal Showing the Initial Silk Filatures**




*Source:* Map reproduced and adapted from Tirthankar Roy, 'Where Is Bengal: Situating an Indian Region in the Early Modern World Economy,' *Past and Present* 213 (1), 2011, p. 117.

After an initial period of approximately six years, when James Wiss and Pickering Robinson - stationed in Bengal - guided the establishment of the first filatures, London took charge. The process of reeling was guided by instructions that came from London and were to be transmitted to the respective filatures by the Board of Trade in Bengal. Filatures were to be sent models of the reeling machines showing the required positions of the wheels, reels and other components. Additional reeling machines were to be constructed in the filature according to these models.[24] The filatures were sent instructions from London about the distances of specific components crucial for the production of skeins of the length commonly used in Europe.[25] The reelers were to be trained in the Piedmontese method and given specific instructions by the overseers and superintendents of the filatures.

The establishment of filatures inevitably altered the procurement and organisation of labour in silk production. Instead of the Company contracting gomastas to procure reeled silk and then contracting them to organize the re-reeling of the country-wound silk, the Company now procured cocoons. At the beginning of each season, Pycars – contracted agents described by the Company as "men […] who go around the country collecting [cocoons]" – were provided with advances to pay Chassars.[26] Chassars were defined as men who rent plantations of mulberry trees, produce mulberry leaves, rear silkworms and produce cocoons.[27]

Reeling was done by Bengalese reelers and, although it cannot be said definitely, it appears that reelers were paid piece wages.[28] Reelers were supervised by

[24] IOR/E/4/620, 23 March 1770, p. 33; IOR/E/4/625, 14 July 1779, pp. 484-86; IOR/E/4/626, 12 May 1780, p. 107; IOR/E/4/640, 25 June 1793, p. 523; IOR/E/4/641, 28 May 1794, p. 423.

[25] IOR/E/1/66 ff. 422-424v: 'Letters 212-213 James Wiss in London to Peter Michell, 10 May 1780', p. 424; IOR/E/4/626, 12 May 1780, p. 104.

[26] Before the implementation of the Piedmontese system, the EEIC relied on several merchant agents to procure raw silk for the European market. After the new system was adopted, the Company only relied on contractors for the procurement of cocoons. At the beginning of each season, Pycars were given advances intended for the peasants, the Chassars. These advances were supposed to enable the peasants to buy silkworm eggs. IOR/E/4/630, 21 July, 1786, p. 548. The Chassars were often unwilling to sell cocoons to the Company because they could earn more if they reeled the cocoons and sold the silk thread on the local markets. Davini, 'Una Conquista Incerta', p. 47.

[27] IOR/E/4/630, 21 July 1786, p. 547.

[28] This was a mayor difference compared to how reelers were paid in filatures in Piedmont, where they were paid time wages. This was supposed to incentivise the reelers to favour quality over quantity of production. Roberto Davini, 'The History of Bengali Raw Silk as Interplay between the Company

overseers, whose task was to ensure that the quantity and quality of the reeled silk met the Company requirements. It was the wish of the Court in London to have one overseer for every 40 furnaces (120 reelers) as was the rule in Italy.[29] However, it can be inferred that the number of reelers per overseer differed among the filatures. Each filature was managed by a director or a superintendent, who was to give instructions and check that the quality of the silk produced in the filature conformed to the Company's requirements.[30]

The process of reeling silk as practiced in the Bengalese filatures is described in the Company's correspondence and in the instructions sent to Bengal. The introduction of the Piedmontese system was accompanied by the adoption of ovens for killing the moths inside the cocoons. Killing moths by heat was an essential improvement because this method was far more effective than exposure to sun which had been used previously.[31] The Company started to procure cocoons from Bengalese peasants; upon arrival to the filature, the cocoons were placed into the oven for the moth to be killed and cocoons were cleaned.[32] It was emphasized that only 'good cocoons', meaning cocoons that had not undergone the process of fermentation – a process of decomposition – were to be used for reeling in the Bengalese filatures.[33] Then the cocoons were reeled using the Piedmontese machine. There is no surviving image of the reeling machine used in Bengal, however, according to an 1838 EEIC's publication the

Bahadur, the Bengali Local Economy and Society, and the Universal Italian Model, c.1750 – c.1830', *Commodities of Empire Working Paper* 6 (2008), p. 15.

[29] IOR/E/4/625, 9 April 1777, p. 219.

[30] Ibid., pp. 176-212.

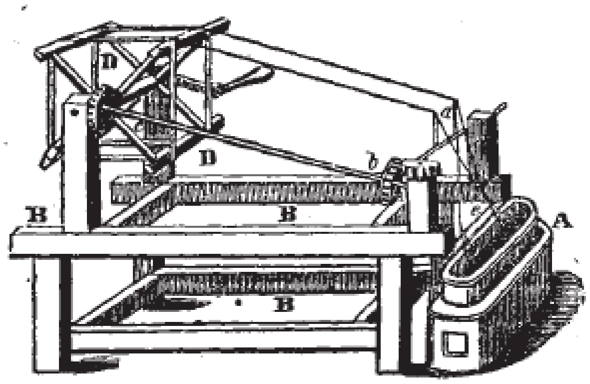
[31] IOR/E/4/625, 9 April 1777, pp. 177-200.

[32] IOR/E/4/625, 9 April 1777, pp. 199-200; IOR/E/4/625, 9 April 1777, p.  220.

[33] IOR/E/4/625, 9 April 1777, pp. 173-84.

machinery used was identical to that described in Dionysius Lardner's book (Figure 3.2).[34]

**Figure 3.2. Piedmontese Reeling Machine as Depicted in Lardner's *Treatise* (1832)**




*Source*: Dionysius Lardner, *A Treatise on the Origin, Progressive Improvement, and Present State of the Silk Manufacture* (Philadelphia: Carey & Lea Chestnut Street, 1832), p. 155.

The image and Lardner's description shows that the reeling machine consisted of three parts: component A depicts the boiler (or basin), B the frame, and D the reel (a full description of the machine can be find in Appendix A). The fire in the furnace brought water in the basin to the boil. The cocoons were placed into the basin in order for the gummy substance covering the filaments to dissolve. A number of filaments were then passed through the reel (D). The reel consisted of wheels with a specific number of teeth, cog wheels and staves and of double crossing-machine, which was introduced by James Wiss to make sure that the thread did not have any lumps.[35]

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[34] LSE Archives, W7204, *Reports and Documents*, p. 16. The image in Lardner's Treatise did not contain a double crossing implement, a central innovation of the Piedmontese reeling machine. Lardner's work, as well as other contemporary sources on silk shows a lack of knowledge in Britain about double crossing in silk reeling. However, in Bengal double-crossing machines were adopted as part of the Piedmontese machine as early as the 1770s, thanks to the fact that James Wiss was familiar with the machines used in Novi, Piedmont.

[35] IOR/E/4/625, 9 April 1777, p. 209; IOR/E/4/627, 12 July 1782, p. 349; IOR/E/1/65 ff. 440-441v: 20 December 1779, p. 440.

Precision during the construction of the reel was essential, because the wheels had to have a specific number of teeth in order to produce high-quality silk thread of specific dimension. The staves had to be set at a defined distance from each other in order to reel silk thread of dimension generally demanded by the European market, that was 40 inches long and 80 inches in circumference.[36] Initially, all the equipment was produced in Novi, Piedmont, and was transported to Bengal.[37] From the second half of the 1770s, models of the equipment were produced in Britain, and sent to Bengal where copies were made.[38] From 1769-96 the Company sent 3,825 sets of cog wheels and 3,833 double-crossing machines to Bengal.[39] The first filatures were established in Bauleah, Commercolly and Kasimbazar. The Commercolly filature had largest capacity with 208 furnaces.[40] The Bauleah and Kasimbazar filature had both 104 furnaces each.[41] Each furnace was furnished with three reels and thus accommodated three reelers.[42]

The cost of setting up a filature was significant. In Bauleah, Commercolly, and Kasimbazar, the cost was estimated to be 284,287 Sicca Rupees (£30,798).[43] However, the costs differed among filatures. Superintendents estimated the cost and committed themselves to building the filature for the estimated sum. It seems that the estimates

[36] IOR/E/4/626, 12 May 1780, p. 105; IOR/E/1/66 ff. 422-424v: 'Letters 212-213', 10 May 1780, p. 424.

[37] IOR/E/4/620, 27 January 1771, p. 396.

[38] IOR/E/4/625, 14 July 1779, pp. 485-86; IOR/E/4/626, 12 May 1780, p. 107; IOR/E/4/640, 25 June 1793, p. 523.

[39] IOR/E/4/626, 12 May 1780, p. 99; IOR/E/4/625, 14 July 1779, p. 484; IOR/E/4/629, 8 July 1785, p. 91.

[40] IOR/E/4/625, 9 April 1779, pp. 131-39; IOR/E/1/61 ff. 355-357v: 3 September 1777, pp. 356-57.

[41] IOR/E/1/61 ff. 355-357v: 3 September 1777, p. 357.

[42] IOR/E/1/61 ff. 486-487v: 18 Nov 1777, p. 486.

[43] IOR/E/4/625, 9 April 1779, pp. 131-32.

were usually met as the only case in which the Company enquired about high expenditure was the building of the Kasimbazar filature by James Wiss in early 1770s.[44]

The investigation into the building of the Kasimbazar filature provides important data as two specialists were contracted in Bengal in the late 1770s to estimate the costs of building a filature of 208 furnaces. They suggested the cost of setting up a filature to be between 67,801 (£7,345) and 84,775 (£9,184) Sicca Rupees. The difference in the estimates is due to the later silk specialist being new to Bengal and dependent on information from natives and Company servants in Bengal.[45] A similar explanation was used by James Wiss to explain why the estimated costs were surpassed: "want of knowledge in the language of a country he was newly arrived in, and his being forced to rely entirely on the Banians, Sircars, Servants during the whole time of the execution of so extensive works".[46] Overall, this reveals two issues: first, the cost of setting up filatures depended on the superintendent's degree of knowledge of the local environment and familiarity with the local language; second, the cost of building larger scale filatures was not significantly higher than building smaller ones. James Wiss, for instance, was granted the finances required for building the Kasimbazar filature once the Court in London recognised that the 208-furnace filature was built for 99,452 Sicca Rupees (£10,774), whereas the combined costs of building the Bauleah and Commercolly filatures, with 104 furnaces each, amounted to 184,835 Sicca Rupees (£20,024).[47]

Considering the quantity of production, the Bauleah filature with 104 furnaces

[44] In this case the costs exceeded the initial estimate due to the increased capacity of production. The filature was initially to have only 100 furnaces but during the construction James Wiss changed the plan and built a filature with a capacity of 208 furnaces.

[45] IOR/E/1/61 ff. 355-357v: 3 September 1777, p. 356.

[46] Ibid., p. 357.

[47] IOR/E/4/625, 9 April 1779, pp. 131-32.

produced 533 maunds 10 Seers 9 chhattaks (39,998 lbs.) of silk in the first four years of its existence. The Commercolly filature with 208 furnaces produced 1096 maunds 32 seers 3 chhattaks (82,260 lbs.). As table 3.1 shows the establishment of the Bauleah, Commercolly and Kasimbazar filatures enabled the Company to double the value of silk procured from the Kasimbazar region in the years between 1772 and 1776.

**Table 3.1. Value of the Raw Silk Procured in Kasimbazar, 1768-1776**

| *Year* | *Value in Rupees* |
|---|---|
| 1768 | 18,000 |
| 1769 | 18,000 |
| 1770 | 18,000 |
| 1771 | 18,000 |
| 1772 | 18,000 |
| 1773 | 28,000 |
| 1774 | 30,000 |
| 1775 | 36,000 |
| 1776 | 36,000 |

*Source:* IOR/E/1/61 ff. 486-487v.: 'Letter 240 James Wiss in London to the Court Outlining the Advantages of the Italian Method of Spinning Silk in Bengal, 18 November 1777', India Office Records and Private Papers, p. 486. This table shows the steep increase in the value of raw silk procured in Kasimbazar after the adoption of the Piedmontese method of reeling in 1773. The filature started to produce in full capacity (208 furnaces) only in the 1775.

The quantity of raw silk reeled in filatures in fact started to expand from the second half of the 1770s, when the number of filatures increased. Filatures were being established by both the Company and private individuals. In order to be able to export 540,000 sm. lbs. of Bengal raw silk – the quantity ordered from London – the Board of Trade in Bengal was instructed to also purchase silk produced in private filatures.[48]

The Company encouraged the establishment of private filatures because it was facing liquidity problems but still wished to quickly enlarge the capacity of filature-

[48] IOR/E/4/628, 11 April 1785, p. 552.

reeled silk in Bengal. The Company was set on drawing the investment in raw silk production in Bengal from the dewany revenues and not to use any additional funds created through drawing of bills of exchange or transfers of bullion. This policy, in conjunction with the expense of war on the Subcontinent, resulted in a shortage of finance for investment in raw silk production.[49] Driven by the goal to increase the trade in filature-made raw silk, the Company decided to allow private individuals to set up filatures.

The adoption of the Piedmontese method resulted in a considerable increase in imports of Bengal raw silk into Britain (Figure 3.3). It is clear that the filatures played an essential role in expanding imports into Britain. However, since the Company continued to import both filature and country-wound silk and did not differentiate between the two in its statistics, the quantity of filature production cannot be definitely ascertained for this period. We know for sure that the Company endorsed the importation of both types of raw silk from Bengal but gave preference to filature silk. This can be inferred from the instructions given to the Board of Trade in Bengal: in 1785, for instance, the Court in London demanded the proportion of silk to be 180,000 sm. lbs. of country-wound silk and 360,000 sm. lbs. of filature silk.[50] The orders of filature silk were further increased in 1796, when the quantity of filature silk requested increased to 420,000 sm. lbs., while orders of country-wound remained stable.[51]

[49] IOR/E/4/618, 24 December 1765, p. 97; IOR/E/4/638, 30 May 1792, p. 470; IOR/E/4/621, 7 April 1773, p. 506; IOR/E/4/623, 5 April 1776, pp. 269-76. IOR/E/4/628, 16 March 1764, pp. 261-65; IOR/E/4/628, 11 April 1785, p. 555.

[50] IOR/E/4/628, 11 April 1785, p. 552.

[51] IOR/E/4/645A, 27 July 1796, pp. 334-38.

**Figure 3.3. Quantities of Bengal Raw Silk Imported into Britain (in sm. lbs), 1764-1798**


*Sources:* Goldsmiths' Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London, n.p., 1795), pp. 6-10; LSE Archives, W7204, East India Company, *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London: J.L. Cox, 1836), p. 3; IOR/E/4/628, 11 April 1785, p. 552; IOR/E/4/645A, 27 July 1796, pp. 334-38. The sharp decline in imports in 1782 and the sudden increase in 1783 was due to delayed harvest and problems with transportation.

Orders are not, however indicative of the quantities of filature silk actually imported. The import of filature silk continued to depend on expanding the capacities of filatures. As can be observed in Figure 3.3, the Company was unable to procure the demanded quantity of filature silk. Imports of country-wound silk were driven by the aim of the Company to meet the order of 540,000 sm. lbs or later 600,000 sm. lbs. per annum rather than by the demand for this type of silk. In 1796 it was reported from

London that country-wound silk had been a losing item of trade in several past sales.[52] It was therefore stated that 'the proportion (180,000 sm. lbs.) of Country Wound Silk … is so ample as not to leave room for any addition. It is the Filature Sort only that can be looked to for any increase'.[53]

The Piedmontese method of reeling was aimed at improving the quality of the Bengal raw silk. This is confirmed by the fact that in Britain filature silk was on average 26 percent more expensive than country-wound silk (Table 3.2). This is a confirmation that buyers recognised the difference in quality between the filature- and country-wound silk.

**Table 3.2. Prices of Filature and Country-Wound Silk at London Sales, 1792-1796**

| Year | Month | Filature-Wound | Country-Wound |
|---|---|---|---|
| **1792** | March | 26s. 10d. | 26s. 3d. |
| | September | 32s. 1d. | 20s. 0d. |
| **1793** | March | 22s. 3d | 18s. 9d. |
| | September | 16s. 7d. | 14s. 0d. |
| **1794** | March | 25s. 9d. | 18s. 8d. |
| | September | 25s. 2d | 21s. 1d. |
| **1795** | August | 26s. 0d. | 16s. 6d. |
| **1796** | February | 24s. 1d. | 17s. 6d. |
| **Mean** | | 24s. 7d. | 19s. 1d. |
| **Median** | | 25s. 6d. | 18s. 6d. |

*Sources:* IOR/E/4/640, 25 June 1793, pp. 513-14; IOR/E/4/643, 3 July 1795, p. 597; IOR/E/4/645A, 27 July 1796, p. 330.

The price difference between filature- and country-wound silk did not imply that the quality of silk ceased to be a problem for the Company. "Complaints made of the badness of this chapter [Bengal raw silk]" were still being reported in the late 1770s.[54] These complaints were the principal reason that the Company contracted a silk

[52] IOR/E/4/645A, 27 July 1796, p. 338.

[53] IOR/E/4/643, 3 July 1795, p. 595.

[54] IOR/E/4/623, 4 July 1777, p. 635.

specialist in London to investigate the quality of raw silk imported from Bengal and advise the Board of Trade in Bengal on how to rectify the problem.[55]

The Company received several complaints about the quality of the silk from a number of silk throwers in Britain. In the 1780s and 1790s the deficient quality of the filature silk became a frequent subject of correspondence between London and Bengal. British manufacturers often complained about the dimensions of the silk, that is the length and width of the skein.[56] Italian silk had set dimensions which were produced by placing the staves of the reel at specific distances from each other.[57] A great deal of the filature silk from Bengal did not comply with these dimensions thus creating problems in the subsequent process of throwing.[58]

Other complaints received by the Company also related to the colour of the silk. This was due to the cocoons going mouldy or undergoing fermentation as a consequence of being stored incorrectly or because of the moths decomposing inside the cocoons.[59] The silk was also found to be too coarse or too uneven.[60] The Company in London reported also the concerns of throwers and manufacturers about ‘unevenness of threads in the same skain [sic], and of foulness of the Silk’.[61] These complaints were often accompanied by the buyer’s reports about being deceived at sales because fine silk was mixed with coarse silk in the same hank.[62]

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[55] Ibid., 4 July, 1777, p. 636.

[56] IOR/E/4/626, 12 May 1780, pp. 105-7.

[57] Ibid., 12 May 1780, pp. 105-6; IOR/E/1/66 ff. 422-424v: ‘Letters 212-213’, 10 May 1780, p. 424.

[58] Silk throwing is a process of twisting and doubling silk threads into silk yarn. This process precedes weaving because silk threads are too fine for direct use in weaving. IOR/E/4/646, 4 October 1797, pp. 822-25 and 829-30; IOR/E/4/645A, 27 July 1796, pp. 341-42.

[59] IOR/E/4/625, 9 April 1777, pp. 176-84.

[60] Ibid., 9 April 1777, p. 177; IOR/E/1/66 ff. 422-424v: ‘Letters 212-213’, 10 May 1780, p. 422.

[61] IOR/E/4/626, 12 May 1780, pp. 111-12.

[62] Ibid., 12 May 1780, pp. 111-14; IOR/E/1/66 ff. 422-424v: ‘Letters 212-213’, 10 May 1780, p. 422.

Complaints about quality did not apply universally to all filatures. Although the correspondence shows that in some seasons the quality of silk was generally lower, some filatures produced silk of a higher-than-average quality. The Court in London often recorded this fact but was unable to do anything about the differences in quality. It also cannot be definitely ascertained whether the private or the Company filatures produced the higher quality silk in all instances. The correspondence contains several complaints about the quality of silk produced in private filatures. For instance, the private filatures of Chapman, Craiggneé and Smith were producing silk which did not comply with the dimensions universally demanded in Europe.[63] On the other hand, the highest quality raw silk was being produced in the private filature owned by James Frushard.[64]

In response to complaints by British manufactures about the quality of raw silk, the EEIC resolved "to consult those persons, who, from their long practice and experience in that branch of business, might be enabled to give us assistance, by suggesting proper observations and directions on the subject".[65] The Company employed several silk specialists in London. Their principal role was to comment on the quality of the silk imported from Bengal, identify the cause of the production of raw silk unsuitable for the British market, and suggest rectifications. Throughout the 1780s and 1790s this role was undertaken by James Wiss and by Mr Tatlock.[66] Both of these silk

[63] IOR/E/4/626, 12 May 1780, p. 106. Only raw silk of specific dimensions could be thrown in throwing mills, otherwise it needed to be wound by hand, which was more expensive.

[64] IOR/E/4/631, 27 March 1787, pp. 695-96.

[65] IOR/E/4/623, 4 July 1777, p. 635.

[66] Mr Tatlock was a silk specialist most often mentioned after James Wiss. However, it seems that Tatlock was not given the same level of trust as Wiss. For instance, Tatlock did not have access to the EEIC's trade and procurement records and he was only allowed to inspect the bales of raw silk imported to London. IOR/E/4/635, 19 May 1790, p. 804.

specialists produced a number of reports giving instructions to the silk filatures in Bengal. Their instructions were endorsed by the Court in London.[67]

These reports were accompanied by information gathered by the Company at the biannual sales which suggests that the main problem was the non-uniformity of the quality of filature silk.[68] Therefore, what type of policies did the Company implement in order to enforce quality of production? And how could the EEIC attain uniformity in the quality of production among its many filatures and private filatures in Bengal?

## 3.3. The Enforcement of Quality in Filature-Raw-Silk Manufacturing in Bengal

The Company relied on the transmission of carefully gathered knowledge of best practices to obtain high-quality raw silk. Silk specialists employed by the Company formulated guidelines that were to be applied universally in Bengalese silk filatures in order to produce silk of a quality that corresponded with the Italian product. These guidelines together with additional instructions formulated by the Court in London were transmitted at least once a year to the Board of Trade in Bengal. This chapter argues that the Court in London lacked the mechanisms to ensure the enforcement of guidelines and that the Company's servants in Bengal were not sufficiently familiar with production techniques to effectively implement such guidelines. Therefore, in spite of having detailed knowledge about the inefficient practices as well as the methods for their rectification, best practices were not always implemented.

[67] See for instance: IOR/E/1/63 ff. 158-160v: 'Letters 70-71 James Wiss in London to the Court making Proposals Relating to Alterations in the Filature of Raw Silk at Calcutta, Related papers attached', 24 October 1778, pp.158-59; IOR/E/1/66 ff. 550-552v: 'Letters 278-279 James Wiss in London to the Court Relating to Silk Manufacture and Orders for Equipment', 10 June 1780, pp. 550-52.

[68] IOR/E/1/66 ff. 422-424v: 'Letters 212-213', 10 May 1780, p. 422.

Correspondence from London shows that the Company understood that the lack of knowledge of the best practices in Bengal was one of the reasons for the production of raw silk of quality inadequate for the European market. Therefore, the Court in London believed that its servants in Bengal needed instructions about the methods of silk production, as it claimed:

> for want of sufficient knowledge and experience [our servants in Bengal], may not be able to instruct the Spinners in every point necessary for obtaining the desired improvements, we now transmit you such regulations as have been suggested by Mr Wiss for that purpose, and direct that our Board of Trade fail not to have them carried into execution.[69]

Apart from noting the underlying lack of knowledge, this quote highlights that their approach was based on silk specialists creating instructions in London which were sent to Bengal to be implemented in the filatures. These instructions addressed not only the issue of quality but also trade in raw silk, and the cost of production of filature-reeled silk.

The guidelines prepared by James Wiss in 1777 according to the experience and information he gathered in Bengal became the essential source of information for the improvement of the quality of filature silk. Abiding to his rules was supposed to guarantee production of standard quality of raw silk. As the Court in London put it, "by due attention to proper rules, and to the various means of improvement herein suggested, the greatest degrees of perfection will soon be attained".[70] These guidelines were cited several times in the following years and they continued to be also mentioned

[69] IOR/E/4/625, 9 April 1777, p. 172.

[70] IOR/E/4/625, 'Mr. Wiss Superintendent of Silk Trade, 9 September, 1777', p. 198.

as the essential source of best practice for raw silk production in EEIC publications as late as 1836.[71]

The original version of the Wiss guidelines of 1777 and the version published in 1807 are extensive and provide precise directives for the directors of filatures and overseers.[72] The directors of the filatures were required to have supplies of clear water and dry wood prepared because clean water was essential for the brilliance of the silk and dry wood for keeping the water in the basins boiling steadily. The directors were also given directions on how best to store cocoons before reeling and were strongly requested to separate damaged cocoons and cocoons undergoing fermentation from the rest. Moreover, they were directed to use ovens to kill moths inside the cocoons. The guidelines also specified the number of cocoons that were to be used for reeling in each bund – rearing period. The quality of cocoons differed over the rearing season, the best were reared in March and November.[73]

The overseers were directed not "to insist on more work being done in a day than is found practicable".[74] Slow reelers were not to be penalized as this would lead them to favour quantity over quality. The overseer was, on the other hand, directed to ensure that the reelers worked efficiently. At the beginning of each season, all of the overseers and the director of the factory were to observe the most capable reelers in producing a sample of the season's production.[75] They needed to ensure that the sample would be of very high quality and that everyone involved in overseeing production would be aware of the quality expected. The guidelines also demanded all silk to be

[71] IOR/E/4/626, 5 July 1780, p. 206; LSE Archives, W7204, East India Company, *Reports and Documents*, p. 16.

[72] IOR/E/4/625, 9 April 1777, pp. 171-216; LSE Archives, W7204, East India Company; *Reports and Documents*, pp. 16-26.

[73] IOR/E/4/625, 9 April 1777, pp. 173-205.

[74] Ibid., p. 206.

[75] Ibid., p. 208.

labelled with the name of the overseer and the director of the filature in order to guarantee direct responsibility for the quality of the produced silk.

## 3.4. Incentives and Compliance to the Guidelines in Bengal

The management of a business enterprise is seldom taken into account as a factor for the success of technology transfers in the pre-industrial period. Management of labour and of the production process were a concern of the pre-modern as well as of the modern entrepreneur. The transition to factory production presented new management challenges. Among them were the high turnover of labour, the poaching of labour force, the lack of discipline among factory workers, the lack of infrastructure, a lack of housing and schooling facilities for workers, and inadequate accounting systems.[76] Most of these problems were also faced by the EEIC in its Bengal filature production.[77] However, the most serious challenge was the incompatibility of the incentives given to the Company's servants and reelers and the production of high-quality filature silk as advocated by the Court in London.

Incentives of economic actors have been studied mostly within game theory. Most historical studies deal with incentives only when focusing on principal-agent

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76 Sidney Pollard, *The Genesis of Modern Management: A Study of the Industrial Revolution in Great Britain* (London: Edward Arnold, 1965), pp. 160-245.

77 The most serious challenge was the high turnover of reelers and workers involved in filature production. This problem was to a large extent associated with the low wages paid. Davini pays particular attention to the high turnover and deems it as one of the major impediments to filature silk production. However, the Company was not unaware of the problem. The director of a filature in Rungpore, for instance, lobbied for an increase in wages for reelers claiming that it would enable him to recruit more reelers and that in spite of the increased wages reelers would still be paid "less than the lowest class of daily labourers…even boys and women". WBSA, BoT (Comm) Prcds 29 March 1791, Letter from Rungpore 10 March 1791, as cited in Davini, Una Conquista Incerta, p. 142. For discussion of labour turnover: Davini, Una Conquista Incerta, pp. 139-44.

problems.[78] Most recently, incentives have been studied from an institutional perspective by Douglas W. Allen. Allen focuses on how pre-modern institutions such as patronage, purchase of offices or duelling were used to align the incentives of navy and army officers, and administrative officials with the goals of the British Crown.[79] His study demonstrates the essential role that institutions play in controlling "bad behaviour by influencing the incentives individuals have to behave in various ways".[80] A focus on the micro-analysis of the incentive structures of agents involved in production is less common. This chapter rectifies this by considering the influence of institutions on the incentives of Company's servants involved in silk production. My conclusion is in line with Allen's findings and claims that institutions played an essential role. However, in the case of Bengal, incentives did not lead to virtuous but to 'bad behaviour'.

The EEIC did not attempt to influence the incentives of its servants involved in silk production. The Court in London relied on the same management practices used for controlling servants whose task was procuring export goods for Europe. The Court believed that transmitting guidelines on the best practices of silk reeling would be sufficient for improving the quality of filature silk. However, the Company was unable to secure compliance with these guidelines in Bengal because the Court in London did not possess the appropriate tools to do so. The Court had direct control only over the conduct of its contracted foreign silk superintendents in Bengal, and had to mostly delegate the enforcement of quality control of filature-reeled silk to the Board of Trade in Bengal. Even if the Board was presented with instructions, the Court in London had

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[78] In economic history, game theory is mostly used to study the fundamental problem of exchange. Avner Greif, 'The Fundamental Problem of Exchange: A Research Agenda in Historical Institutional Analysis', *European Review of Economic History*, 4 (3), 2000, pp. 251-84.

[79] Douglas W. Allen, *The Institutional Revolution: Measurement and the Economic Emergence of the Modern World* (London: University of Chicago Press, 2012), pp. 44-146.

[80] Ibid., p. 12.

limited control over the Board's conduct itself. Therefore, the guidelines from London were often disregarded.

Santhi Hejeebu pointed to the fact that the combination of access to private trade and the threat of losing their privileges with dismissal was a sufficient incentive to motivate the EEIC servants to fulfil orders from London.[81] Hejeebu, nevertheless also acknowledges the problem that the Directors in London faced when attempting to ascertain whether decisions taken by servants in Bengal were acts of "mature consideration" or "malfeasance".[82] Such problems were acute in silk production. The Piedmontese success in production of high-quality silk thread was achieved due to a combination of technological leadership, precision and minute regulation.[83] These elements were lacking in Bengal filature production. It was difficult for the Court in London to ascertain whether this was due to lack of familiarity with the best practice, as the Company servants were not experts in silk production, or whether it was due to lack of attention to the task.

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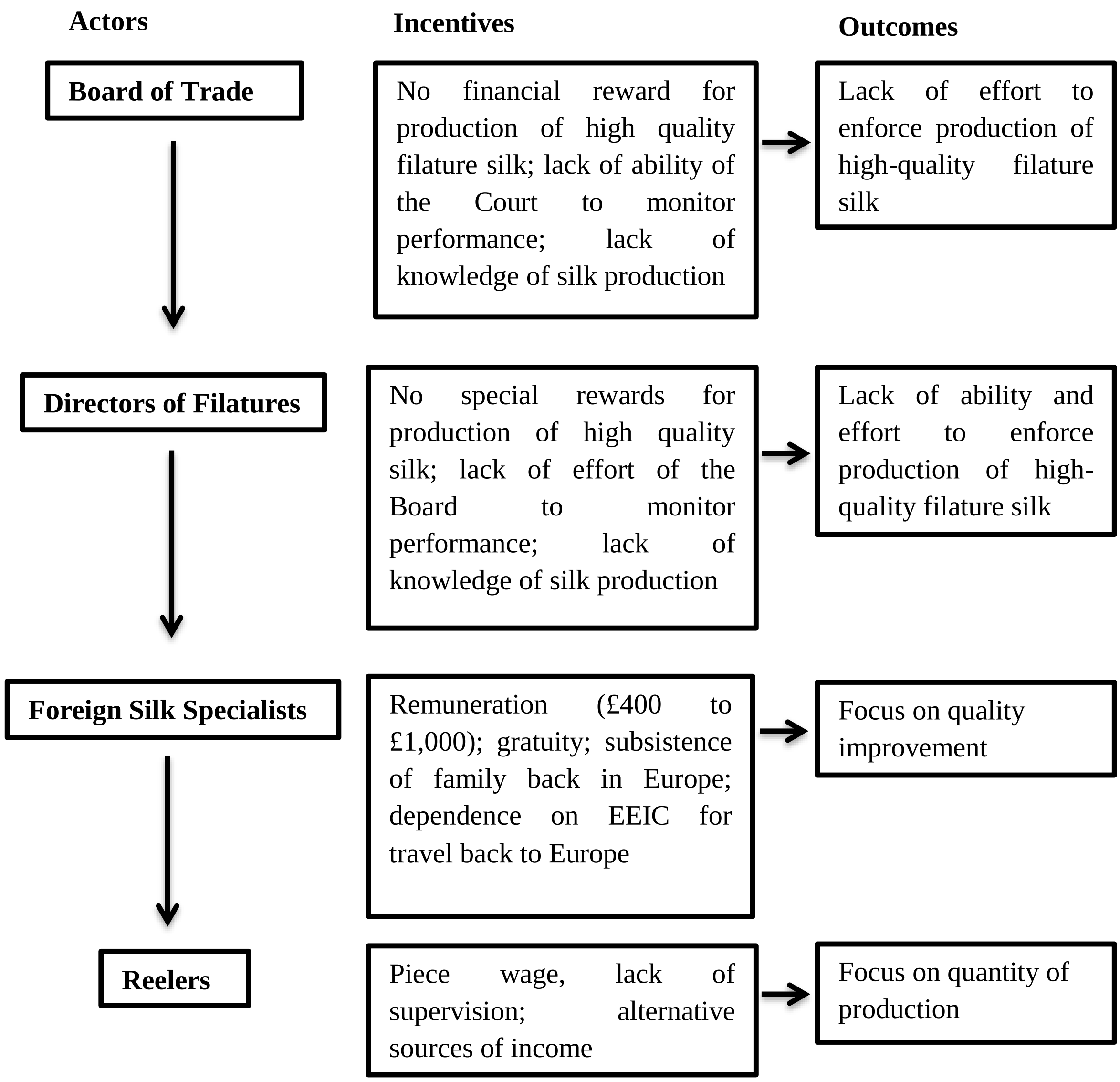
[81] Santhi Hejeebu, 'Contract Enforcement in the English East India Company', *Journal of Economic History*, 65 (2), 2005, pp. 498-500.

[82] Ibid., p. 508.

[83] William Aglionby, 'Of the Nature of Silk, as It is Made in Piedmont', *Philosophical Transactions* 21 (1699), p. 184. See also: Mauro Ambrosoli, 'The Market for Textile Industry in Eighteenth Century Piedmont: Quality Control and Economic Policy, *Rivista di Storia Economica* 16 (3), 2000, pp. 344 and 346; Claudio Zanier, 'Pre-Modern European Silk Technology and East Asia: Who Imported What?' in Debin Ma. (ed.) *Textiles in the Pacific, 1500-1900*. *The Pacific World: Lands, Peoples and History of the Pacific, 1500-1900* (Aldershot: Variorum, 2005), p. 114; Davini, 'History of Bengali Raw Silk', pp. 4-5. In general, regulation played an important role in enforcing quality in the Italian silk industry, see, for instance: Carlo Belfanti, 'Guilds, Patents, and the Circulation of Technical Knowledge: Northern Italy during the Early Modern Age', *Technology and Culture* 45 (3), 2004, pp. 570-2, 574 and 576-8; Carlo Poni, 'Comparing Two Industrial Districts: Bologna and Lyon in the Early Modern Period', in Pier Luigi Porta, Roberto Scazzieri, Andrew S. Skinner (eds.), *Knowledge, Institutions, and the Division of Labour* (Cheltenham: Edward Elgar, 2001), p. 201.

**Figure 3.4. Incentives of Servants and Reelers Employed in Filature Silk Production**




The inability of the Court to measure the performance of its servants became a central issue. In the case of procurement of goods for export, the Court was able to monitor whether orders were fulfilled and goods sent to Europe. Monitoring compliance with orders concerning silk production was however more difficult because the quality of filature silk was the only reliable indicator. In such a case, the Court needed to present its servants with incentives that would guarantee their focus on the improvement of quality. Douglas W. Allen state that presenting agents with the right incentives was essential for achieving goals by the British Crown during the pre-modern era when measuring performance and monitoring results was impossible.[84] Figure 3.4 shows that the incentives received by the Board of Trade in Bengal, directors of filatures, reelers, and foreign silk specialists were mostly incompatible with production of high-quality silk.

The contracted silk specialists were the only servants employed in the filature production whose conduct could be monitored by the Company. There were never more than three silk specialists employed as superintendents of silk filatures and up to ten silk reelers and mechanics at any one time (for as many as ten head filatures and numerous smaller filatures all around Bengal). Therefore, it was easy to monitor their conduct, especially in the case of superintendents who were frequently in direct contact with London. Moreover, as these specialists were usually foreigners and were dependent on the EEIC to travel back to Europe, it was essential for them to satisfy the orders received from London.[85] Moreover, silk specialists were not allowed to enter private trade thus limiting the possibility of a conflict of interest with the Court in London. Their remuneration did represent a premium high enough to motivate the foreign specialists to commit to contractual obligations. Silk superintendents received between £400 and £1,000 a year, and silk reelers and mechanics circa £40 per year. To put the remuneration into perspective, it would take 11 years of service in Bengal for a

[84] Allen, *Institutional Revolution*, pp. 20, 109-140 and 217-27.

[85] The possibility of not being admitted onto the Company's ships posed a real threat for the foreign specialists as the case of silk reelers G. Ruggiero and D. Poggio show. These Italian silk reelers were not allowed to board the Company's ships because of alleged misconduct. Their case was handled by James Wiss, who was able to convince the Court of their good service record. IOR/E/1/63 ff. 16-18v : 7 July 1778, pp. 16-17.

Company servant to receive £40 a year.[86] Furthermore, the families of the silk specialists left in Europe also received subsistence. The silk specialists could also have their contract extended, their salary increased, or obtain a gratuity for their services to the Company.[87]

No special incentives were provided for the Board of Trade and the directors of filatures and the Court did not put any enforcement mechanisms in place – yet it relied on these servants to carry out quality improvements. I argue that the enforcement of quality improvement did not receive sufficient attention. Providing guidelines from London was simply insufficient. Contemporary traders, technicians, politicians and political economists from all over Europe solely attributed the Piedmontese success to their superior reeling technology but omitted to mention the importance of regulation.[88] In Piedmont, as well as in other places in Italy, various institutional innovations emerged to regulate the quality of silk.[89] In Piedmont, merchants as well as the State were dependent on silk exports for income and custom revenues.[90] The enforcement of high-quality production was essential to success and both merchants and the State became involved in it. The process of silk thread production was regulated by the State and quality was strictly enforced. As emphasised by Mauro Ambrosoli, the State "supervised the whole process of production, issuing instructions, laws, and regulations, granting trading privileges".[91] The best practice in reeling was "enforced by minute

[86] Hejeebu, 'Contract Enforcement', p. 502.

[87] James Wiss was, for instance, given a gratuity of £1,000 for his services in Bengal. IOR/E/4/625, 9 April 1779, pp. 133-34.

[88] Davini, 'Global Supremacy', p. 91. It was pointed out by Claudio Zanier that the Piedmontese supremacy in silk reeling hinged on changes in sericulture, in the training of labour, and in organisation of production. Zanier, 'Pre-Modern European Silk Technology and East Asia', p. 139.

[89] Belfanti, 'Guilds, Patents, and the Circulation of Technical Knowledge', pp. 574 and 576-8.

[90] For instance: Ambrosoli, 'Market for Textile Industry', p. 344.

[91] Ibid., p. 346.

regulations ordered by the Consulate of Commerce, a direct issue of the King himself".[92]

The Court was unaware that servants' incentives were incompatible with the production of high-quality silk and continued to rely on the dissemination of guidelines about the best practices to be adopted. Silk production in Bengal was a recurring topic in the correspondence from London. First, it called on the Board of Trade in Bengal to promote the dissemination of knowledge of the best practice in silk reeling.[93] Second, the Court demanded that all Company servants involved in a trade with a particular item would "improve themselves in the knowledge of such parts of our Investments, as come under their Superintendance".[94] Third, the Board of Trade was also to ensure that the respective overseers, superintendents and directors of silk filatures were made responsible for the quality of the silk produced.[95]

The Company faced non-compliance to these rules and to the guidelines prepared by James Wiss. The multiple instances in which high-quality silk was mixed with a coarse one, or when low-quality silk was brought to Britain because best practice was not followed, gives a clear indication that reelers, overseers and/or directors did not abide by rules. The Court in London stressed the necessity of labelling silk with the name of the factory, superintendent or director, overseer and warehouse keeper 'by which means we may in case of any deficiency discover to whose negligence the same is erring and accordingly require such Servants to make good any loss which shall be sustained by us on that account'.[96] However, the accounts do not contain any cases

[92] Ibid., p. 344.

[93] IOR/E/4/623, 4 July 1777, p. 636; IOR/E/4/625, 9 April 1777, p. 172.

[94] IOR/E/4/623, 24 December 1776, p. 281.

[95] IOR/E/4/625, 9 April 1777, pp. 223-24.

[96] IOR/E/4/621, 25 January 1772, p. 211; IOR/E/4/625, 9 April 1777, p. 226.

where a servant in Bengal was brought to account.[97] The documents solely note the names of the persons responsible for the quality of the filature silk to be missing or to be changing very frequently due to fluctuation of servants working in silk production.[98]

The Court often repeated the view that with due attention to “proper rules, and to the various means of improvement herein suggested, the greatest degrees of perfection will soon be attained”.[99] However, attention was lacking as was the Company servants’ knowledge of silk production. The lack of attention to implementing the guidelines sent from London should be attributed to the Board of Trade however. Correspondence demonstrates that the Court mostly displayed trust in the Board of Trade. The Court, for instance, stated: “We trust you will issue such direction as may have a tendency to remedy as much as possible, the defects complained of”.[100] However, the instances, on which the Court needed to repeat its orders and call for their implementation were numerous.[101] This illustrates the inability of the Court in London to promote quality improvement, particularly because it lacked information on whether the inaction of the Board was deliberate. The Court had only limited control over its servants in Bengal.

Lack of familiarity with the methods of silk production among the EEIC servants in charge with enforcing the quality of filature production similarly undermined the process of transmitting regulations. With the exception of foreign silk

[97] The only case I found in which the EEIC dismissed servants due to misconduct related to silk production, was a dismissal by the Board of Trade. Although, this is a case of great magnitude, it is not connected to neglect of enforcement of quality in silk production but to fraudulent behaviour and embezzlement. See IOR/E/4/630, 12 April 1786, pp. 391-93.

[98] IOR/E/4/625, 9 April 1777, pp. 225-26; IOR/E/4/626, 5 July 1780, p. 219.

[99] IOR/E/4/625, 9 April 1777, p. 198.

[100] IOR/E/4/645A, 27 July 1796, p. 336.

[101] IOR/E/4/628, 11 April 1785, p. 551; IOR/E/4/629, 8 July 1785, p. 91; IOR/E/4/629, 21 September 1785, p. 197; IOR/E/4/630, 12 April 1786, p. 181; IOR/E/4/631, 27 March 1787, p. 704-05; IOR/E/4/634, 8 April 1789, p. 699.

specialists, none of the Company's servants had experience in silk production. The London Court ordered the Company's servants to improve their knowledge of silk manufacturing and trade several times. However, no further steps were taken to train its servants in Bengal. It was supposed that they would learn the necessary skills once they joined the branch of commerce. Moreover, servants employed in overseeing the quality of the silk production were frequently changing their residence and/or branch of trade.[102] Such fluctuation of workers had a negative impact on the quality of production as familiarity with the production techniques was essential. Frequent personnel changes in those responsible for filature production also deterred buyers as they could not rely on specific directors or superintendents of filature to guarantee quality. At times the lack of knowledge of reeling practices among the supervisors and directors of filatures was brought to the attention of the London Court. This was for instance the case of a filature directed by Mr Burges that sent good quality silk reeled over coarse silk. The Company believed that this was due to Burges being deceived by reelers as he lacked sufficient knowledge of reeling.[103]

Considering the labour management, the EEIC created several new posts in order to supervise and manage filature production. In Bengal the post of Superintendent General and the posts of Superintendents of warehouses in Calcutta were created, and in Britain the post of Inspector of raw silk in the EEIC's warehouses. The creation of the later post was suggested by James Wiss, one of the silk specialists employed by the EEIC in Bengal:

> I still believe that an Inspector of the Bengal Raw Silk at your Warehouses here, may supply the place of a Superintendent General in Bengal, if not exactly to all Intents and purposes, at least very Essentially; particularly being

[102] IOR/E/4/625, 9 April 1777, p. 226.

[103] IOR/E/1/66 ff. 422-424v: 'Letters 212-213', 10 May 1780, p. 422.

> acquainted with the quality of Cocoons in Bengal at the different seasons of the year, he may make choice of samples of such Italian silks as may be imitable at each Factory, and have them fixed as the standards by which the spinners ought to Work; and by examining the produce of every Factory separately, and making his remarks, this Inspector will find out from whence the defects originate and point the means of avoiding them.[104]

The Court in London approved the creation of such a post, and agreed with Wiss on the role and tasks that were to be carried out by the Inspector. It appointed James Wiss upon his arrival from Bengal in 1777 to the post.[105] The Court was convinced that the problems with the quality of the filature silk were caused by a lack of knowledge of the best practices by its Bengal servants and therefore was convinced that employing a silk specialist in the London warehouses would significantly help to mitigate the problem. Creating such a post decidedly helped the Court to gain precise knowledge of 'bad' practices employed in filature production in Bengal and about their possible rectifications. However, neither the Inspector in the London warehouses not the Superintendent General in Bengal were able to enforce the implementation of best practices. The Court continued to rely on the Board of Trade to implement the guidelines and orders sent from London.

In its many attempts to enforce quality of production, the EEIC neglected positive incentives. In 1838 Giuseppe Mutti, a silk specialists employed by the EEIC in India, pointed to the importance of proper instruction for reelers, and the benefits of motivating them through rewards. He claimed that to obtain silk of good quality "it only

[104] IOR/E/1/63 ff. 90-91v: 'Letter 41 James Wiss in London to Sir George Wombwell Proposing the Appointment of an Inspector of the Bengal Raw Silk and Offering his Services for Such a Post', 8 September 1778, p. 90.

[105] IOR/E/4/625, 9 April 1777, p. 171.

requires some practice [training] and patience … [and] finally from time to time to reward him [reeler] with some presents for his exertions. – No such things are observed here and as to presents it is said to be an extravagance adding the man has got his (or good) pay”.[106]

## 3.5. Conclusion

The introduction of the Piedmontese system of reeling to Bengal was supposed to enable the EEIC to produce ‘Bengal Italian raw silk’ and thus improve the quality of raw silk destined to Britain. This chapter argues that filatures were key to the implementation of knowledge transfer. Vertical integration brought about by the filature system decreased the costs of instruction as well as the costs of adoption of the new machinery and enabled proper maintenance of the reeling machinery. This argument reflects Mokyr’s proposition that factories emerged when costs of moving information became higher than costs of moving people. The adoption of the Piedmontese system of reeling necessitated changes in organization of labour, in procurement and the introduction of a system of quality enforcement.

In spite of the adoption of the Piedmontese system, British silk manufacturers continued to complain about the quality of the Bengal raw silk. This chapter shows that the quality of the filature silk was lower than the Piedmontese and at times of very low quality due to lack of quality enforcement. The Company did not introduce any quality enforcement mechanism and did not innovate its management practices, or align the incentives of its servants with the production of high-quality silk. It relied solely on transmission of guidelines about best practices. However, the Board of Trade in Bengal and the servants frequently failed to implement these ‘best practices’. I argue that in the

[106] IOR, Bombay (Misc. Public Documents, etc.)., 1793.m.17: ‘Letter from Giuseppe Mutti’, p. 7.

case of silk production, the threat of dismissal was not a sufficient mechanism to ensure that the servants in Bengal supported the production of high-quality silk. First, the servants themselves were often not sufficiently familiar with methods of silk production to effectively implement and oversee the Piedmontese reeling method. Second, the Court in London lacked information to discern whether the guidelines were not enforced due to the malfeasance of its servants or due to their servants' inability to enforce them.

# CHAPTER 4

## The English East India Company's Trade in Bengal Raw Silk

> The deep-rooted prejudices that formerly prevailed against it [Bengal raw silk] are daily vanishing, and the article is proportionately rising in the public esteem; but it is evident that its future success will altogether depend upon the degree of attention that shall continue to be paid to its quality. If there shall be the least relaxation on this important point, the character to which it has arrived by flow gradations will at once be lost, and the flattering hopes which the company have been looking to, of retrieving the heavy sums which have been sunk in bringing this article to its present state of perfection (which is little less than a million sterling), be totally annihilated.[1]

The demand for Bengal raw silk and its price on the British market was dependent upon its quality. The quality of silk in turn depended on the attention the Company agents paid to its production, selection and control. This chapter considers the development of the Company's silk trade in the second half of the eighteenth century. As described in the previous chapter, the Battle of Plassey (1757) and the acquisition of the dewani of Bengal, Bihar and Orissa (1765) marked the beginning of British imperialism in India.[2] From one among several European East India companies, the EEIC became the ruler of a vast territory. This marked a turning point for the Company's interests in the Bengal silk industry. This new administrative and political power enabled the Company to put

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[1] L/PARL/2/55: 'Appendix to the Fourth Report from the Select Committee on the Affairs of The East India Company, 1812, India Office Records and Private Papers', p. 217.

[2] Sushil Chaudhuri, *Prelude of Empire: Plassey Revolution of 1757* (New Delhi: Manohar Publishers, 2000), pp. 9-10.

into operation a plan based on altering the reeling methods of raw silk production in an attempt to improve its quality. This was essential for expanding the trade in Bengal raw silk and for capturing higher shares of the British raw silk market.

This chapter addresses the demand for raw silk on the British market. Second, it analyses the development of the EEIC's trade in Bengal raw silk from the 1750s to 1812. Finally, it studies the attempt of the EEIC to use the expedient silk that accumulated in the warehouses in silk throwing. Its overall aim is to show that in spite of the adoption of the Piedmontese reeling system, large part of the imported Bengal raw silk was of substandard quality and this curtailed its sales in the British market.

## 4.1. The British Market for Raw Silk

The British silk industry is often equated with Spitalfields silk weaving. In spite of the fame that the Spitalfields production attained between 1730 and 1760 and the scholarly attention it has received over the past two generations, the majority of the British silk production was of lower quality in comparison to other world producers and was mostly focused on small items rather than high-quality cloth.[3] The British silk industry produced mostly smaller wares and haberdashery. The typology of the wares produced underpinned the demand for raw silk on the British market. Whereas broad weaving necessitated silk thread of the highest quality (in most cases the threads needed to be thrown into organzine before they could be used), most of the British silk weaving

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[3] Spitalfields' reputation was made by the accomplished work of designers such as Joseph Dandridge, John Vansommer, Christopher Baudouin, James Leman and Anna Maria Garthwaite. Natalie Rothstein. *Spitalfields Silk* (London: Stationary Office, 1975), pp. 1-2. See also: Frank Warner, *The Silk Industry of the United Kingdom: Its Origin and Development* (London: Drane´s, 1921), p. 42; Natalie Rothstein, 'The Silk Industry in London, 1702-6' (Unpublished MA Thesis, University College London, 1961); Id., *Silk Designs of the Eighteenth Century: From the Collection of the Victoria and Albert Museum* (London: Thames and Hudson, 1990); and Gail Malmgreen, *Silk Town: Industry and Culture in Macclesfield 1750-1835* (Hull: Hull University Press, 1985), p. 8.

industry only needed medium-quality raw silk.[4] The silk used was neither too fine nor too coarse and had to be easily workable – i.e. without the need to re-reel it prior to utilisation. Thus, the EEIC did not necessarily need to produce the finest raw silk in Bengal, but silk of a quality good enough to produce small wares.

The British silk industry was primarily a producer of silks of middle to low quality and specialized in smaller wares, such as small articles of haberdashery; ribbons, trimmings, buttons, handkerchiefs, gloves, hosiery, stockings, galloons, and bandannas, and fabrics such as bombanzines, crapes and gauzes, and sewing silk.[5] In the eighteenth century, the principal silk manufacturing regions were London, Norfolk, Dorset, the Midlands, Cheshire, Lancashire, and Staffordshire. Spitalfields, in London, was a major centre of manufacture focusing principally on the production of broad textiles. The West Midlands region, and especially Coventry, focused instead on the production of ribbons; Cheshire on mixed fabrics and Norwich on the production of bombanzines and crapes. Moreover, Macclesfield was a centre of silk throwing, whilst Lancashire produced ribbons.[6]

The climatic conditions of the British Isles would not allow the cultivation of mulberry trees and silkworm rearing. The British silk industry was therefore totally

[4] The quality of raw silk was extremely important in determining the quality of the final product – silk cloth or a smaller ware such as ribbon. Luca Molà has mapped out that the variety of the different types of raw silk used in the Italian silk industry in the early modern period. Molà also points to the fact that raw silk was divided according to the regions it came from, as well as according to its quality into several classes. Luca Molà, *The Silk Industry of Renaissance Venice* (Baltimore: Johns Hopkins University Press, 2000), pp. 55-56.

[5] Warner, *Silk Industry of the United Kingdom*, p. 42; Malmgreen, *Silk Town*, p. 8; D. C. Coleman, *Courtaulds: An Economic and Social History, Volume I The Nineteenth Century Silk and Crape* (Oxford: Clarendon Press, 1969), p. 23.

[6] Gerald B. Hertz, 'The English Silk Industry in the Eighteenth Century', *English Historical Review* 24 (96), 1909, p. 714; Jean-Francois Fava-Verde, *Silk and Innovation: the Jacquard Loom in the Age of the Industrial Revolution* (Ebook: Histancia, 2011), p. 6.

dependent on imports of raw silk. In the eighteenth century, most of the raw silk used in England was procured from Italy, the Mediterranean, Turkey, China and India. In the early eighteenth century most of the lower-quality raw silk was procured from Turkey, Spain and Portugal and was used in the production of smaller wares. Silk from Turkey was used, for instance, in the production of damasks, galloons and stockings.[7] The best-quality raw silk was imported from Italy from where Britain imported also thrown silk. Only Italian raw or thrown silk was used in broad weaving.[8] High-quality Chinese silk was also imported as it was appreciated for its whiteness. It was used principally in the production of hosiery and gloves.[9] Bengal raw silk, by contrast, was considered of the lowest quality to be found on the market and its use prior to the 1770s was limited.[10]

British weavers either bought thrown silk directly on foreign market or imported raw silk and had it thrown into yarn in mills outside London.[11] According to Gerald B. Hertz, some 947,000 lbs. of raw silk was thrown per annum in Britain in the period 1785 to 1812.[12] In spite of the increasing quantities of raw silk thrown in Britain, the manufacture of silk cloth and other products was not without problems. First, there were problems with the quality of raw silk available for throwing. Second, the sector often experienced fluctuation in demand for thrown silk. In the 1720s, Britain lost access to

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[7] Hertz, 'English Silk Industry', p. 711.

[8] Goldsmiths' Library [G.L.], 1796 fol. 16654, *Considerations on the Attempt of the East-India Company to Become Manufacturers in Great Britain* (London, 1796), pp. 12, 18 and 31. The best-quality thrown silk came from the region of Piedmont and was called organzine. Hertz, 'English Silk Industry', p. 711, Coleman, *Courtaulds: An Economic and Social History*, pp. 16-17.

[9] Dionysius Lardner, *A Treatise on the Origin, Progressive Improvement, and Present State of the Silk Manufacture* (Philadelphia: Carey & Lea Chestnut Street, 1832), p. 68.

[10] Ibid., p. 67.

[11] Fava-Verde, *Silk and Innovation*, p. 6.

[12] Hertz, 'English Silk Industry', p. 721.

the best-quality raw silk available on the market – the Piedmontese raw silk.[13] Without access to the Piedmontese raw silk, the silk yarn thrown in British mills could never compete with thrown silk produced in Italy. That could have been a minor problem considering that broad weaving – which required the highest quality silk - was only a small part of the entire British production. However, although lower-quality silk was sufficient for the weaving of ribbons and smaller wares, it frequently broke when being thrown in mills. This had a negative impact on the quality of thrown silk as well as on the efficiency of mill throwing. Complaints about the quality of silk threads and their frequent breakages were common especially for the Bengal raw silk.[14]

Silk throwing was also negatively affected by periods of stagnation in silk weaving. Figure 4.1 shows the fluctuation of the exports of British silk manufactures: the industry went through phases of expansion followed by stagnation. After a stagnation period lasting from the 1720s to the 1750s, the industry went through a phase of expansion in the 1760s as the British silk industry captured most of the French trade in silk during the Seven Years' War (1756-63). The slump that the industry suffered once peace was established could only be overcome by a prohibition of the import of all

[13] The decision of the King of Savoy to ban exports of Piedmontese raw silk to Britain was a retaliation against the setting up of a hydraulic silk throwing mill in Derby by the Lombe brothers in 1718. John Lombe obtained the designs of the technology in Italy illegally and his story became one of the best known cases of pre-modern industrial espionage. [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London, n.p., 1795), p. 2; Lardner, *Treatise on the Origin,* p. 62; S. R. H. Jones, 'Technology, Transaction Costs, and the Transition to Factory Production in the British Silk Industry, 1700-1870', *Journal of Economic History* 47 (1), 1987, pp. 75-77; Giuseppe Chicco, *La Seta in Piemonte 1650-1800: Un Sistema Industriale d'Ancien Regime* (Milano: Franco Angeli, 1995), pp. 71-96.

[14] IOR/E/4/627, 12 July 1782 p. 351; IOR/E/4/625, 9 April 1777, p. 175.

foreign silks and velvets.[15] Unfortunately, the stagnation of the industry could not be reversed and low levels of production and export continued until 1810s.[16]

**Figure 4.1. Exports of British Silk Manufactures, 1750-1808**


*Source:* Data adapted from B. R. Mitchell, *British Historical Statistics* (Cambridge: Cambridge University Press, 1988), p. 364.

The stagnation of the British silk weaving industry obviously had also negative consequences on the demand for raw silk. However, fluctuation in the demand for raw silk on the British market was not the sole factor that negatively affected the demand for Bengal raw silk. The quality of the Bengal silk remained the main issue affecting the demand for Bengal raw silk throughout the eighteenth and early nineteenth centuries. First, not all of the Bengal raw silk was of quality high enough to be used in production of even small wares. Complaints about the coarseness and inequality of threads continued even after the implementation of the Piedmontese system.[17] Moreover, some

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[15] Coleman, *Courtaulds: An Economic and Social History*, p. 18.

[16] Ibid., p. 20.

[17] IOR/E/4/623, 4 July 1777 p. 635; IOR/E/4/625, 9 April 1777, pp. 176-84; IOR/E/1/66 ff. 422-424v: 'Letters 212-213 James Wiss in London to Peter Michell', 10 May 1780, p. 422.

of the Bengal silk was not easily workable because it needed to be re-reeled before use. The ease with which it could be used was one of the reasons for the popularity of Italian silk.[18] Moreover, Bengal raw silk frequently broke, especially during throwing. This was caused by the improper handling of cocoons. Cocoons often went mouldy when stored in the Company's filatures. This had a negative effect on the quality of the silk thread as mouldy cocoons had their gummy substance – which makes silk thread strong and flexible – weakened. Also the use of unclean water in reeling weakened the flexibility of the thread.

Despite the fact that the consumption of silk textiles spread beyond the elites already in the late Middle Ages, and silk started to be consumed by wider social strata, the quality of the silk thread still played a key role.[19] The quality of the thread was regulated by the market demand not by a state-imposed institutional framework or by guilds.[20] Silk thread necessary for dress accessories such as bonnets, hats, gloves, belts, stockings, and shoes – items of common use also among the less wealthy social strata – did not need to be made of such high-quality thread as broad weaving.[21] Yet, in spite of

[18] [G.L.], 1796 fol. 16654, *Considerations*, pp. 3 and 12-13.

[19] For changing consumption patterns of finished silks see: Beverly Lemire and Giorgio Riello, 'East & West: Textiles and Fashion in Early Modern Europe', *Journal of Social History* 41 (4), pp. 890-92.

[20] Such approach was taken by the French and English government in the eighteenth century but only in respect to finished products. Philippe Minard, Pierre Gervais and Judith Le Goff, 'Colbertism Continued? The Inspectorate of Manufactures and Strategies of Exchange in Eighteenth-Century France', *French Historical Studies* 23 (3), 2000, p. 479; William J. Ashworth, 'Quality and the Roots of Manufacturing "Expertise" in Eighteenth-Century Britain', *Osiris* 25 (1), 2010, pp. 238-44.

[21] John Styles has shown that haberdashery made of silk was commonly worn by the lower social strata in the eighteenth-century England. See John Styles, *The Dress of the People: Everyday Fashion in Eighteenth-Century England* (New Haven: Yale University Press, 2007), pp. 30-32; Id., 'Clothing the North: The Supply of Non-Élite Clothing in the Eighteenth-Century North of England', *Textile History* 25 (2), 1994, pp. 155-56. Apart from haberdashery, the production of mixed textiles also used silk thread of lower quality. For instance, the Italian silk industry started producing waste and second-choice silks already from the fifteenth century despite the fact that the practice was treated unfavourably by the guild officials. Molà, S*ilk Industry of Renaissance Venice*, pp. 90 and 163-67.

the specialisation of the eighteenth-century British silk industry in the production of smaller wares rather than on the highest quality broad silks, the Company's focus on increasing the quality of the Bengal thread was well reasoned. Without quality improvements, the Company-imported silk could not gain higher market shares because its use remained limited even in the production of haberdashery. Haberdashery necessitated silk of certain standards of quality as to be ready to be used and without the need to be reworked prior to throwing and reeling.[22]

## 4.2. The English East India Company's Trade in Bengal Raw Silk

The quality of raw silk was the single most important factor determining the demand and price of Bengal silk on the British market. The adoption of the Piedmontese system of silk reeling led to significant quality improvements with positive effects on demand and prices. However, quality issues remained, driving down both prices and demand. The quantity of Bengal raw silk imported into Britain in the 1770s-1810s was dependent on external factors – draughts and other natural hazards, as well as internal factors such as the lack of investment.

[22] RSA/SC/EL/2/31. *Third Report of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London: n.p., 1795), pp. 6-7 and 11-14. Although a switch to the production of lower-quality and more affordable silk occurred in broad weaving as the competition from printed cotton textiles negatively affected demand for silk textiles, the major shift came in the second part of the nineteenth century. In broad weaving demand for comparatively lower quality silk thread increased only in the second half of the nineteenth century in conjunction with the rise of the American silk manufacturing sector. The US-made silk textiles were not of quality as high as the European silks and were intended for the consumption of the middle classes. Lemire and Riello, 'East & West', pp. 890-92; Debin Ma, 'The Great Silk Exchange: How the World was Connected and Developed', in Debin Ma. (ed.), *Textiles in the Pacific, 1500-1900. The Pacific World: Lands, Peoples and History of the Pacific, 1500-1900* (Aldershot: Variorum, 2005), pp. 24 and 26; Kazuko Furuta, 'Silk Reeling in Modern East Asia: Internationalization and Ramifications of Local Adaptation in the Late 19th Century', in Ma. (ed.), *Textiles in the Pacific*, pp. 17 and 20-21.

The Company's commercial interest in Bengal raw silk dated back to the breakdown of the negotiations between Sir Thomas Roe and the Sophy of Persia in 1617, which aimed at securing the EEIC the monopoly in the trade of Persian silk.[23] The trade in Bengal silk was promoted from 1675 when the well-known Company servant Streynsham Master was sent to India with the specific task of obtaining information about the best type of raw silk to be bought in the Bay of Bengal, the best season and method to buy silk, the weight of raw silk and its price.[24] The legislation of 1699, 1702 and 1720 curtailed the Company's possibilities to legally import finished silk fabrics into Britain.[25] The Company continued trading in silk fabrics though most of them were legally re-exported, particularly to the North American colonies.[26] The Company however did not seem to ascribe the trade in silk fabrics such importance as the trade in raw silk.

Throughout the seventeenth and the first half of the eighteenth century the position of the Bengal raw silk in the British market remained marginal.[27] The reputation of the Bengal raw silk among the European silk manufacturers and weavers was one of low quality. The main complaint was that it was coarse and unequal in

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[23] J. Geoghegan, *Some Account of Silk in India, Especially of the Various Attempts to Encourage and Extend Sericulture in that Country* (Calcutta: Department of Revenue and Agriculture, 1872), p. 1.

[24] Streynsham Master, *The Diaries of Master: The Diaries of Streynsham Master 1675-1680*, ed. Richard Temple (London: J. Murray, 1911), p. 204.

[25] Chaudhuri, *The Trading World of Asia*, p. 344. Prior to 1757 the Company was interested in both wrought and raw silk. Only after 1757 it started to focus mainly on raw silk. Indrajit Ray, 'The Silk Industry in Bengal during Colonial Rule: The 'Deindustrialisation' Thesis Revisited', *Indian Economic Social History Review* 42 (3), 2005, p. 340.

[26] Rothstein, *Spitalfields Silk*, pp. 1-2. In theory, all the imported silk fabrics were re-exported. However, evidence shows that in some periods smuggling and illegal sale of silk was large. Ray, 'Silk Industry in Bengal during Colonial Rule', pp. 344-45 and 359-64.

[27] Although the data about the share of raw silk on the total imports of raw, thrown and waste silk is not available, there is no indication that the share changed significantly in the period 1773-92. In this period the share of raw silk to the total import of raw and thrown silk into Britain was 69% on average.

skeins and could only be used for haberdashery.[28] William Aglionby summarized the attributes of good quality silk to be lightness, equality of silk threads in respect to fineness, smoothness and strength. Individual threads had to be strong and clean. He especially noted the need of equality of threads in skeins: "it is likewise convenient, that the Skeans be even and all of an equality, which shews they were wrought to gether; otherwise with great reason one may suspect that it is refuse Silk, and cannot be equally drawn out and spun, for one Thread will be shorter than the other, which is Labour and Loss. It will be also requisite to search the Bale more than once […] for unless one buys that which one knows by tryal, there is a hazard of being Cheated, and so, for one sort, have another."[29] Bengal raw silk failed to attain these standards of quality and necessitated reworking prior to utilisation.[30] The problems with the quality of the raw silk were so serious that at times they threatened to halt the trade altogether.[31] The Court in London commented that "the Badness of the Raw Silk has been of late the occasion of constant complaint and unless it is provided cheaper and better that once valuable article can have no share in our Trade".[32] This may explain why the quantity of Bengal raw silk imported into Britain before 1760 was very small allowing for only 8.7 percent of all raw silk imported to the country (table 4.1).

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[28] [G.L.], 1796 fol. 16654, *Considerations*, p. 21; Goldsmiths´ Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, pp. 13; Chaudhuri, *Trading World of Asia*, p. 346.

[29] Although the text was written at the end of the seventeenth century, no change of technology or fashion which would lead to increased demand for different qualities of silk thread occurred. William Aglionby, 'Of the Nature of Silk, as It is Made in Piedmont', *Philosophical Transactions* 21 (1699), pp. 184-85.

[30] The silk could not be used for throwing or weaving without being first re-reeled.

[31] LSE Archives, W7204, East India Company, *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London, J.L. Cox, 1836), p. iv.

[32] IOR/E/4/616: 'Bengal Raw Silk Investigated by Richard Wilder, 25 March 1757', India Office Records and Private Papers, p. 656.

**Table 4.1 The Share of Bengal Raw Silk on the Total Imports of Silk Imported into Britain, 1750-1789**

| Year | Total Average Annual Imports of Raw Silk | Quantity of Bengal Raw Silk as % of Total |
|---|---|---|
| **1750-60** | 388,091 | 8.7 |
| **1773-79** | 930,202 | 43.2 |
| **1780-89** | 889,371 | 45.0 |

*Source:* Compiled from B. R. Mitchell, *British Historical Statistics* (Cambridge: Cambridge University Press, 1988), p. 343; K. N. Chaudhuri, *The Trading World of Asia and the English East India Company, 1660-1760* (Cambridge: Cambridge University Press, 1978), p. 534, Goldsmiths' Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London, n.p., 1795), pp. 6, 10 and 14.

The adoption of the Piedmontese method of reeling brought the Company a partial success. Table 4.2 shows that Bengal became quantitatively the most important exporter of raw silk to Britain. As the importation of raw silk from Bengal increased, importation of raw silk from Aleppo, Valentia, Naples, Calabria and other places in Mediterranean decreased.[33] Nonetheless, the quantities of raw silk imported into Britain continued to fluctuate even after the adoption of the new system (Table 4.2). These fluctuations were caused by factors external as well as internal to the EEIC's policies. The Company's efforts at increasing the quantity of raw silk exported to the British market were also curtailed by several external factors such as dearth, inundations, storms and similar natural events that diminished the supply of cocoons or labour force in Bengal.[34]

[33] LSE Archives, W7204, East India Company, *Reports and Documents,* p. xxiv.

[34] [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses,* p. 18.

**Table 4.2. Quantities of Raw Silk Imported into Britain, 1773-1792**

| Year | Italy and Turkey | Rest of Europe | China | Bengal | Total |
|---|---|---|---|---|---|
| **1773** | 187,099 | 6,190 | 203,401 | 145,777 | 542,467 |
| **1774** | 220,933 | 2,610 | 276,781 | 213,549 | 713,873 |
| **1775** | 272,782 | 13,380 | 167,229 | 208,881 | 662,272 |
| **1776** | 515,235 | 22,048 | 244,839 | 515,913 | 1,298,035 |
| **1777** | 350,640 | 42,451 | 221,902 | 563,121 | 1,178,114 |
| **1778** | 130,636 | 12,558 | 266,678 | 602,964 | 1,012,836 |
| **1779** | 850 | 13,503 | 234,906 | 737,560 | 1,103,819 |
| **1780** | 844 | 209,557 | 0 | 235,216 | 445,617 |
| **1781** | 23,878 | 288,906 | 602,601 | 785,673 | 1,701,058 |
| **1782** | 3,789 | 178,084 | 79,725 | 77,610 | 373,313 |
| **1783** | 140,866 | 129,758 | 241,107 | 611,071 | 1,122,802 |
| **1784** | 262,419 | 74,688 | 100,602 | 1,149,394 | 1,587,103 |
| **1785** | 245,230 | 25,996 | 98,920 | 324,307 | 694,453 |
| **1786** | 222,175 | 35,101 | 59,551 | 252,985 | 569,812 |
| **1787** | 185,983 | 21,583 | 366,878 | 178,180 | 752,624 |
| **1788** | 148,922 | 23,207 | 312,182 | 305,965 | 790,276 |
| **1789** | 148,582 | 23,881 | 257,022 | 427,263 | 856,648 |
| **1790** | 194,974 | 25,953 | 216,005 | 320,826 | 757,758 |
| **1791** | 294,103 | 38,288 | 203,539 | 373,503 | 909,433 |
| **1792** | 358,500 | 45,881 | 104,830 | 380,107 | 889,318 |
| **Total** | 3,908,440 | 1,233,623 | 4,258,698 | 8,409,865 | 17,961,631 |
| **Average** | 195,422 | 61,681 | 212,935 | 420,493 | 898,082 |
| **Average Share** | 21.8 | 6.9 | 23.7 | 46.8 | |

*Source*: Goldsmiths' Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London, n.p., 1795), p. 6-10. Between 1779 and 1783 Italian raw silk was being imported to Britain mostly via other European countries due to war. This explains the sudden increase in imports from other parts of Europe and decrease in imports from Italy. [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, p. 6-10.

Similarly, the problems that the Company encountered in extending the mulberry cultivation also had a negative impact on silk production. The peasants proved to be risk-averse, giving preference to crops with lower returns but more stable prices.[35] This evidence supports the argument proposed by Benoy Chowdhuri, that Bengali peasants were allocating their resources – land and labour – in order to maximize returns.[36]

Roberto Davini reached similar conclusions in relation to silk cultivation and argued that the Bengali peasants were autonomous economic actors taking decisions according to market incentives.[37] The evidence also supports the view that rural markets were operating according to economic laws, rather than the view that after the Battle of Plassey forced commercialisation took place.[38] Apart from these exogenous shocks, the Company's investment also played a significant role. The Company's investment policy changed in conjunction with demands for military and administrative provision. Although, the precise information about the Company's yearly investments into raw silk

[35] Ibid.

[36] Benoy Chowdhury, 'The Process of Agricultural Commercialisation in Eastern India during British Rule: A Reconsideration of the Notions of Forced Commercialisation and Dependent Peasantry', in Peter Robb (ed.), *Meanings of Agriculture: Essays in South Asian History and Economics* (Delhi: Oxford University Press, 1998), pp. 71-91.

[37] In his dissertation and publications, Roberto Davini emphasizes that the Company had little power over peasants, merchants or even intermediaries. Roberto Davini, 'The History of Bengali Raw Silk as Interplay between the Company Bahadur, the Bengali Local Economy and Society, and the Universal Italian Model, c.1750 – c.1830', *Commodities of Empire Working Paper* 6 (2008), pp. 9-10; Roberto Davini, 'Una Conquista Incerta: La Compagnia Inglese delle Indie e la Seta del Bengala, 1769-1833' (Unpublished PhD Thesis, European University Institute, 2004), pp. 19-27, 46-51 and 120-9. However, I argue that although the EEIC did not have coercive power over producers, it could raise the prices or wages it paid peasants to achieve its goals. Considering the cheapness of labour in Bengal, a moderate increase of wages would not have threaten the profitability of filature production.

[38] It has been contended by authors like Bashkar Mukhopadyay that after the Battle of Plassey, which secured EEIC political and administrative power over Bengal, the Company was able to coerce textile workers. Bashkar Mukhopadyay, 'Orientalism, Genealogy and the Writing of History: The Idea of Resistance to Silk Filature in Eighteenth Century Bengal', *Studies in History* 11 (2), 1995, pp. 210-11.

is incomplete, the documents show that it fluctuated between £275,894 and £715,281 in the 1780s. However, when waging war, the investment fell to as low as £102,183.[39]

Besides imports it is also important to examine the prices of the Bengal raw silk on the British market. The EEIC expected that Bengal raw silk reeled according to the Piedmontese method would attain a price increase of about 25 percent.[40] As stated in the previous chapter, the data shows that filature silk attained prices 26 percent higher than the country-wound silk (Table 3.2). However, that does not mean that the price of Bengal raw silk was comparable to that of raw silk from other parts of the world. If the price of Bengal raw silk is compared to the price of other types of raw silk imported into the British market, it becomes apparent that Bengal raw silk did not improve its position, even when a crude estimate such as average first cost is considered. Table 4.3 shows that in 1770, before the adoption of the Piedmontese system, the average first cost – the initial expenditure incurred before the silk got to the market – of Bengal raw silk was 11s., whereas for all other types of silk it was 17s. The low first cost indicates that the price at which Bengal silk was sold by intermediary merchants was lower than in the case of other silks. That is an indication that it also attained lower prices if sold on the Europeans market. Even after the implementation of the Piedmontese system in 1780 the first cost of Bengal silk was still estimated to be 11s.

Quantitative data is supported also by qualitative evidence. Bengal raw silk continued to be considered as the lowest quality silk in the market. The Company had to

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[39] [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, pp. 18-19. Such evidence runs contra to Lucy S. Sutherland's findings that in the late 1760s and early 1770s the Company was increasing its Bengal investment in spite financial difficulties. Lucy S. Sutherland, *The East India Company in Eighteenth-Century Politics* (Oxford: Clarendon Press, 1952), p. 225.

[40] IOR/E/1/61 ff. 486-487v.: 'Letter 240 James Wiss in London to the Court Outlining the Advantages of the Italian Method of Spinning Silk in Bengal, 18 November 1777', India Office Records and Private Papers, p. 486.

wrestle with the continuing perception by British manufacturers and contemporary economic writers that Bengal raw silk was a material "fit only to be used in the lowest descriptions of manufactured goods, and its price in the English market, generally, was equal to about one-third of that of Italian silk".[41]

**Table 4.3. Comparison of the Average First Cost of Raw Silk Imported into Britain, 1769-70 and 1779-80**

| Year | Import | Type of Raw Silk | Estimate of First Cost | Amount Sm. lbs. | Value £ | s. | d | Average First Cost |
|---|---|---|---|---|---|---|---|---|
| **1769/70** | East India | Bengal | 10 to 12s. 6d | 250,232 | 137,627 | 8 | 4 | **11s.** |
| | Canaries | Raw Silk | 15 to 19s. | 719 | 611 | 3 | 0 | **17s.** |
| | France | Raw Silk | 15 to 19s. | 99 | 83 | 17 | 4 | **17s.** |
| | Holland | Bengal | 10 to 12s. | 98 | 53 | 18 | 0 | **11s.** |
| | | Italian | 15 to 19s. | 173 | 146 | 15 | 4 | **17s.** |
| | Italy | Italian | 15 to 19s. | 135,584 | 115,246 | 2 | 4 | **17s.** |
| | Spain | Spanish | 15 to 19s. | 10,132 | 8,611 | 12 | 8 | **17s.** |
| | Streits | Italian | 15 to 19s. | 2,690 | 2,286 | 1 | 6 | **17s.** |
| | Turkey | Turkey | 15 to 19s. | 111,979 | 95,182 | 3 | 0 | **17s.** |
| | Venice | Italian | 15 to 19s. | 1,650 | 1,402 | 15 | 8 | **17s.** |
| | Carolina | Raw Silk | 15 to 19s. | 297 | 252 | 13 | 3 | **17s.** |
| **1779/80** | East India | Bengal | 10 to 12s. | 381,777 | 209,977 | 10 | 8 | **11s.** |
| | | China | 10 to 12s. | 75,679 | 41,623 | 5 | 4 | **11s.** |
| | Flanders | Italian | 15 to 19s. | 124,964 | 106,219 | 13 | 8 | **17s.** |
| | Holland | Italian | 15 to 19s. | 6,504 | 5,529 | 5 | 0 | **17s.** |
| | | Turkey | 15 to 19s. | 3,000 | 2,550 | 0 | 0 | **17s.** |
| | Italy | Italian | 15 to 19s. | 4 | 3 | 13 | 8 | **14s.** |
| | Spain | Spanish | 15 to 19s. | 64 | 55 | 5 | 0 | **17s.** |
| | Venice | Italian | 15 to 19s. | 559 | 474 | 17 | 4 | **17s.** |

*Source:* The National Archives (TNA), Records of the Board of Customs, Excise and Customs and Excise, and HM Revenue and Customs. CUST 3/70 – Ledgers of Imports and Exports, 1770; TNA, CUST 3/80 – Ledgers of Imports and Exports, 1780.

[41] John Crawfurd, *An Inquiry into some of the Principal Monopolies of the East India Company* (London: James Ridgway, 1830), p. 2.

As contemporary silk expert claimed Bengal raw silk was "of the commonest kind and fit only for inferior purposes, acceptable to the English manufacturer".[42] The general consensus of the pamphleteers was that the lower quality of Bengal raw silk meant that it could fetch only a third or half of the price of Italian raw silk on the British market.[43] Attempts by the EEIC to present filature-made Bengal raw silk as a product of significantly higher quality were undermined by a lack of quality enforcement which led to the frequent occurrence of substandard quality silk on sales. The reputation of Bengal raw silk thus remained low.[44]

Data on Bengal silk prices for the period 1770-1800 is incomplete; yet it shows major fluctuations in 1760-70: whereas in 1765 one gr. lbs. of Bengal raw silk was sold for 26s. 12d, in 1771-72 it fetched around 18s. 8d.[45] Such price fluctuations reflected the development of the British silk industry – characterised by expansion in 1760s, a slump in 1770s and subsequent stagnation until 1810 – rather than being an indication

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[42] Lardner, *Treatise on the Origin*, p. 66.

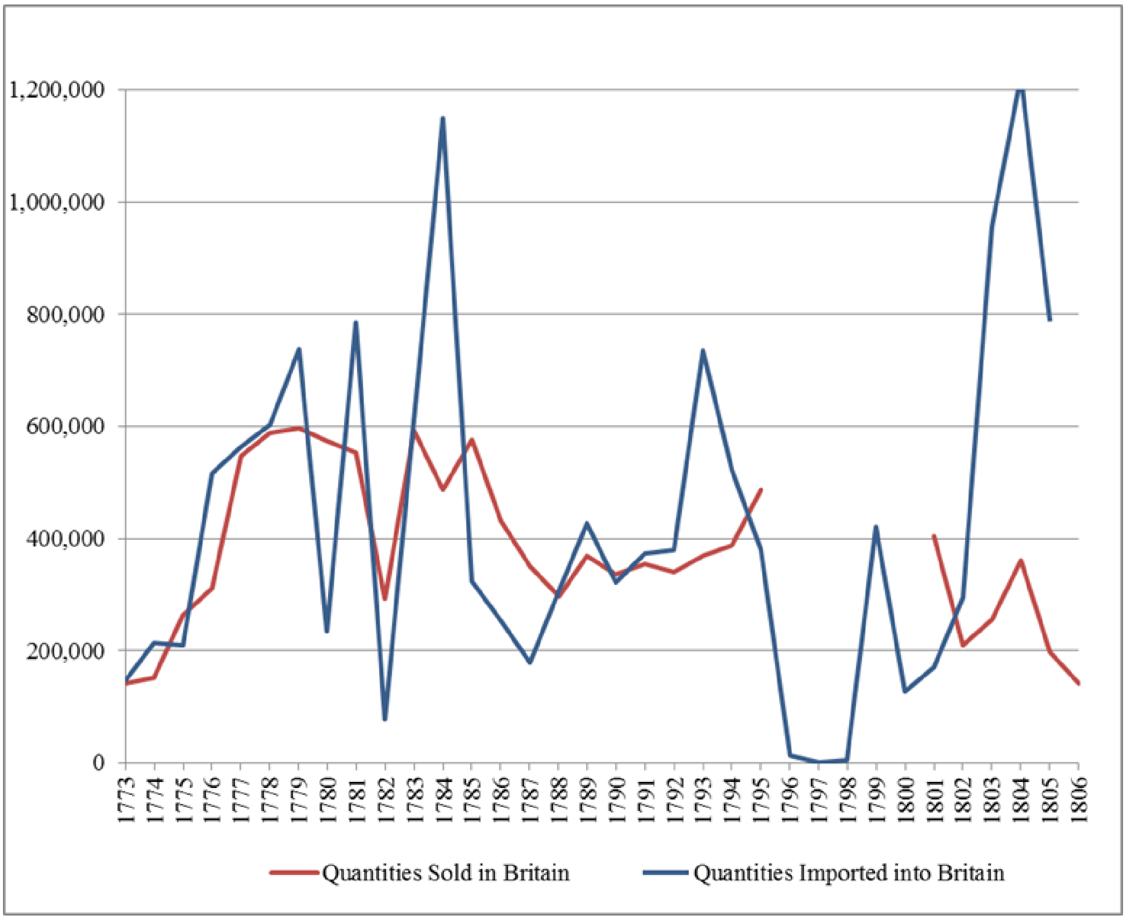
[43] Ibid.

[44] The reputation of the Bengal filature-made silk was also undermined by the imports of private trade silk. The Company was obliged by the 1793 Charter Act to sell the silk imported by private merchants in the Company sales. The Company was not in favour of this arrangement on the ground that the sale of the Bengal raw silk imported by private merchants had damaging effects for the reputation of the filature-reeled Bengal raw silk. The position of the Company's filature-reeled silk on the market was still precarious. Buyers were generally sceptical about the quality of Bengal raw silk and unwilling to investigate the qualitative difference between the EEIC-imported and private-imported silk. The Company complained that most of the silk imported by private traders was "badly worked, foul, gouty" and that it showed the same defects "for which Bengal Silk was formerly so much reprobated". The EEIC further complained that the importation of private silk led to decreases of the price of the Company's silk estimated to be 18d. to 1s. per pound. Although the exactness of these figures is questionable, the assumption that private silk drive down prices seems to be well founded. L/PARL/2/55: 'Annex to the Fourth Report', p. 217-19.

[45] Under the British pre-decimal monetary system (pre-1970), 12 pence (d.) were equivalent to a shilling (s.). There were 20 shillings to a pound (£). The five pence are units of account as the smallest denominator was 1/8 of a pence.

of the quality of Bengal raw silk.[46] In 1772-75, when the first filature-wound silk reached the British market, it was sold at around 24s. In 1792-96 filature silk sold on average for 24s. 7d. Although on some occasions the filature silk sold for as little as 22s. 16d or even for 16s. 7d, overall the fluctuations were not so severe and there is a reason to expect that the price oscillated around 24s. in 1770s-1800s.[47]

**Figure 4.2 Bengal Raw Silk Imported and Sold in Britain by the EEIC, 1773-1806**




*Source*: Compiled from: Goldsmiths' Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London, n.p., 1795), p. 6; L/PARL/2/55: Appendix to the Fourth Report of the Select Committee on the Affairs of the East India Company', pp. 218 and 232; IOR/E/4/645, 27 July 1796, p. 552.

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[46] Coleman, *Courtaulds: An Economic and Social History*, p. 14-20.

[47] IOR/E/4/645A, 27 July 1796, p. 330; IOR/E/4/643, 3 July 1795, p. 597.

Equally important is the analysis of the volume of Bengal raw silk sold on the British market. Once again the data is incomplete (Figure 4.2).[48] The data shows that fluctuations were not uncommon and most importantly that import of Bengal raw silk surpassed the sales of this silk. During 1773-95 the EEIC accumulated 651,783 sm. lbs. of unsold Bengal raw silk in its warehouses and in 1801-05 an astonishing 2,658,693 sm. lbs. Overall, the inability to sell large quantities of Bengal raw silk was the issue that most severely affected the Company's silk trade. This became a serious issue that the EEIC needed to address. Besides adopting measures to further improve the quality of the silk, the Court in London tried also to find new channels of consumption for Bengal raw silk.

## 4.3. Silk Throwing in Britain and the English East India Company

The silk supplied by the EEIC from Bengal did not completely match the demand for raw silk in Britain. Due to its poor quality – real or perceived – large quantities of silk remained unsold. At the same time, the adoption of the Piedmontese technology put pressure on the Company to sell large quantities of silk to recover its investment. To increase the consumption of Bengal raw silk, the Company started to look for new channels of distribution and consumption. This was underpinned by the decline of silk production – principally of broad-weaving – in Britain in the 1790s which altered the demand for raw silk.[49] The Court considered that the best solution was to throw Bengal raw silk into organzine in Britain.[50] The Court defined its motivation as follows:

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[48] Sales were most probably also affected by the decline of the British silk industry, which I discuss below.

[49]The EEIC explained the decline of silk broad weaving in Britain as the result of the competition by the emerging cotton textile industry and by the limited importation of Italian organzine during the French

> our only object being to effect an increased Consumption of an Article raised in British Territories, at a fair and reasonable rate of Price, but we are perfectly convinced that unless the Company take upon themselves, at their own risk, to establish the undertaking on a firm and solid basis, no Individuals will be found adventurous enough to hazard their property on some novel and untried Speculation.[51]

It is apparent that the Company considered the plan risky but worth pursuing because it expected that throwing Bengal raw silk into yarn would generate profits. The Company hired silk mills in England and in 1794 started producing organzine. However, the plan was undermined by technical difficulties and by the opposition of the British manufactures. The Company started to implement the plan at a juncture when mercantilism was slowly giving way to laisser-faire policies and British manufactures saw the EEIC's plan as an attempt on the part of the Company to secure the monopoly of silk throwing on the domestic market.[52]

In spite of not being able to import the targeted 540,000 sm. lbs. of filature silk into Britain, the Company was still left with large quantities of unsold silk. The Court of Directors expected that 540,000 sm. lbs. was the maximum quantity of Bengal raw silk that could be imported into Britain without decreasing the price of raw silk on the

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Revolutionary wars. The crisis was exacerbated by the comparatively lower quality of British broad weaves. This is confirmed also by the anonymous pamphleteer, who criticized the Company's plan to produce organzine from Bengal raw silk. He questioned in particular whether the introduction of lower-quality organzine was going to help the British silk industry. [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, pp. 2-5; [G.L.], 1796 fol. 16654, *Considerations on the Attempt of the East-India Company*, p. 11.

[50] Lardner, *Treatise on the Origin*, p. 65.

[51] IOR/E/4/643, 3 July 1795, p. 588.

[52] [G.L.], 1796 fol. 16654, *Considerations*, pp. 4-5.

market.[53] In the 1790s the market got severely overstocked. On the 19 February 1794, it was reported that 700,000 sm. lbs. of Bengal raw silk were to be found in the Company's warehouses and another 105,000 sm. lbs. in the hands of intermediary buyers.[54] Available statistics indicate that the imports surpassed sales (Figure 4.3). Similarly, the Company's letters sent from London to Bengal indicate that the market was overstocked with Bengal raw silk.[55] It was at this point that the EEIC came up with a plan to start throwing Bengal raw silk into organzine in Britain.

The Company was eager to start producing organzine in Britain on a large scale and used the rhetoric of serving the needs of domestic manufacturers and of creating employment to support its objective.[56] However, in spite of this rhetoric, the dominant consideration for the EEIC was to increase the consumption of Bengal raw silk in Britain in order to recover its investment into Bengal filature silk production. The Court assigned a high-level of importance to the plan, "deeming it expedient to enlarge their imports of Bengal raw silk […] by throwing some portion of it into Organzine".[57] The Court's support of the production of organzine was easily explained by the need to recover the large investment made in Bengal. Four reports to the Select Committee on the Affairs of The East India Company submitted in 1812 explained the situation: the EEIC's finance and investment policies were undergoing an audit by the British government and it was important for the Company to present Bengal raw silk as a profitable item bringing benefits to British manufacturers.

[53] IOR/E/4/628, 11 April 1785, p. 552.

[54] [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, p. 19.

[55] See for instance: IOR/E/4/645A, 27 July 1796, p. 330.

[56] [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, pp. 1-2.

[57]Ibid., p. 1.

**Table 4.4. Quantity of Thrown Silk Annually Imported into Britain, 1773-1794 (in sm. lbs.)**

| Years | Italy | Other Parts of Europe | Total |
|---|---|---|---|
| **1773-75** | 357,493 | 1,099 | 358,592 |
| **1776-85** | 178,256 | 214,662 | 392,918 |
| **1786-90** | 356,445 | 35,301 | 391,746 |
| **1790-94** | 333,924 | 36,077 | 370,001 |
| **Total** | 5,972,963 | 2,426,437 | 8,443,694 |
| **As % of Total** | 70.8 | 29.2 | 100 |

*Source*: Goldsmiths' Library [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses of the East-India Company relative to Extending the Trade on Bengal Raw-Silk* (London, n.p., 1795), p. 11; IOR/E/4/645A, 27 July 1796, p. 331.

Since the limiting factor against increasing the use of Bengal raw silk in throwing was its quality, Company's reports published in the 1790s aimed to publicize the quality of the filature-made raw silk to the British manufacturers.[58] Moreover, the objective was also to claim that the manufacturers as well as public would gain from the domestic production of organzine made from the Bengal silk in Britain. The Company yet again drew on mercantilist rhetoric: it claimed to promote employment and decrease the dependency on Italian imports.[59] The EEIC was also trying to present Bengal raw silk as a profitable item. In the reports to the British government, the EEIC presented Bengal raw silk as an item of steady profit: "a new channel of consumption had been successfully opened for introducing it into organzine; there was good grounds to

[58] In 1790s the Company published three reports focusing on trade in raw silk and presented possible way of increasing the imports of Bengal raw silk. [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, pp. 1-32; RSA/SC/EL/2/31, *Third Report of the Committee of Warehouses*, pp. 1-14.

[59] The Company claimed that the throwing of Bengal raw silk into organzine would give employment to 7,000 people in Britain. [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, p.1.

believe, that the Company's Import might be safely extended as far as about 4,000 Bales per annum [that is 596,278 lbs.]".[60] The Court expected that some 300,000 sm. lbs. of thrown silk could be produced each year in Britain with the use of Bengal raw silk. This was a major plan as such quantity was approximately 79 percent of the total annual imports of thrown silk into Britain 1773-94 (table 4.4).

In 1794 when the EEIC decided to venture into the production of organzine, Bengal raw silk was already being used for throwing into trams and singles in British mills.[61] British manufacturers never considered throwing Bengal silk into organzine because they regarded its quality insufficient for such a purpose.[62] This happened because of two problems. First, technical issues limited the use of the silk for throwing as Bengal raw silk was not of sufficient strength and frequently broke during throwing.[63] Second, organzine made of Bengal silk was of lower quality than organzine made of Italian silk.[64] The silk threads that Bengal raw silk consisted of were not round: they had lumps and broke frequently because they lacked strength and flexibility.[65] These problems could not be corrected in the process of throwing and so the silk yarn continued to suffer from such shortcomings. Since the quality of the silk yarn used in

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[60] L/PARL/2/55: 'Annex to the Fourth Report', p. 217.

[61] Singles is yarn twisted from single threads and single twisted. Trams are double twisted silk threads used as weft. LSE Archives, W7204, East India Company, *Reports and Documents,* xxviii; Lardner, *Treatise on the Origin,* p. 67.

[62] Lardner, *Treatise on the Origin,* p. 67.

[63] IOR/E/4/627, 12 July 1782, p. 351; IOR/E/4/625, 9 April 1777, p. 175.

[64] [G.L.], 1796 fol. 16654, *Considerations,* pp. 3, 12-3, 18, 31. Even Lardner, who was in favour of the Company's plan to throw Bengal raw silk into organzine, points out that an increase in the quality of the silk was needed before it could substitute Italian organzine. Lardner, *Treatise on the Origin,* p. 67.

[65] G/23/13: 'Factory Records: Kassimbazar, 1757-59', India Office Records and Private Papers, pp. 93-94, 96 and 108; IOR/E/4/625, 9 April 1777, p. 209; IOR/E/4/627, 12 July 1782 p. 349; IOR/E/1/65 ff. 440-441v: 20 December 1779, p. 440; LSE Archives, W7204, East India Company, *Reports and Documents*, p. 28; [G.L.], 1796 fol. 16654, *Considerations*, p. 21; [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*), pp. 13; Chaudhuri, *Trading World of Asia*, p. 346.

broad weaving is decisive for the quality of the final product, weavers were reluctant to use such organzine and the mill owners to throw Bengal raw silk into organzine.

The experiment of throwing Bengal silk in Britain started in 1794. The idea of the Court was to "throw some of it [filature silk] into Organzine for the purpose of ascertaining whether it could not be introduced as a proper substitute for some portion of the silk of that description at present furnished by the Italian states".[66] The experiment was considered as promising. At the first sale in 1795, the Company sold 3,901 sm. lbs. of organzine at an average of 26s. 4d per sm. lbs. In 1796 it sold a further 8,775 sm. lbs. at 27s. 9d.[67] In 1795 the Court on the whole evaluated the results positively: "although it had some Prejudices to contend against, it produced upon whole Prices sufficiently encouraging to afford room for belief that with proper Care and Attention in the first Operation of Winding, the Measure may eventually be attended with the desired Success".[68] Encouraged by the results the EEIC decided to proceed with the plan.

The EEIC was involved in throwing Bengal raw silk into organzine for 21 years, from 1794 to 1815. Table 4.5 shows that the Company was able to throw on average only around 20,000 sm. lbs. per year in this period, well below the 300,000 sm. lbs. target. The overall imports of thrown silk in 1794-1815 were on average 385,636 sm. lbs. per year. This means that the silk thrown by the EEIC accounted for only 5.5 percent of total imports of thrown silk. Therefore, the plan cannot be considered successful. A comparison of the prices of Bengal raw silk and organzine made of such silk for years 1795-96 reveals that the EEIC was making losses in throwing. Bengal raw silk sold in 1795 for 26s. and in 1796 for 24s. 1d., the prices of thrown silk were only

[66] IOR/E/4/643, 3 July 1795, p. 586.

[67] RSA/SC/EL/2/31, *Third Report of the Committee of Warehouses,* pp. 4-5.

[68] IOR/E/4/643, 3 July 1795, p. 587.

4d. higher in 1795 and 3s. 8d. a year later.[69] There is no evidence suggesting that throwing became more profitable in the following years.

**Table 4.5. Comparison of the Quantity of Raw Silk Thrown into Organzine by the EEIC and the Quantity of Thrown Silk Imported to Britain, 1794-1815**

| Year | Thrown on Account of EEIC (lbs.) | Imported (lbs.) | EEIC Thrown Silk as % of Imported Thrown Silk |
|---:|---:|---:|---:|
| 1796 | 25,948 | 399,000 | 6.5 |
| 1797 | 19,961 | 402,000 | 5.0 |
| 1798 | 9,085 | 403,000 | 2.3 |
| 1799 | 16,426 | 468,000 | 3.5 |
| 1800 | 20,511 | 335,000 | 6.1 |
| 1801 | 32,691 | 275,000 | 11.9 |
| 1802 | 29,717 | 396,000 | 7.5 |
| 1803 | 25,618 | 385,000 | 6.7 |
| 1804 | 45,407 | 449,000 | 10.1 |
| 1805 | 27,492 | 433,000 | 6.3 |
| 1806 | 51,847 | 515,000 | 10.1 |
| 1807 | 40,620 | 346,000 | 11.7 |
| 1808 | 29,452 | 415,000 | 7.1 |
| 1809 | 11,485 | 502,000 | 2.3 |
| 1810 | 13,869 | 451,000 | 3.1 |
| 1811 | 13,547 | 20,000 | 67.7 |
| 1812 | 10,883 | 618,000 | 1.8 |
| 1813 | 4,380 | 0 | 100.0 |
| 1814 | 10,796 | 646,000 | 1.7 |
| 1815 | 6,434 | 358,000 | 1.8 |
| **Total** | 468,715 | 8,484,000 | 5.5 |
| **Mean** | 21,296 | 385,636 | 5.5 |
| **Median** | 19,047 | 400,500 | 4.8 |

Source: LSE Archives, W7204, East India Company, *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London, J.L. Cox, 1836), p. 7; B. R. Mitchell, *British Historical Statistics* (Cambridge: Cambridge University Press, 1988), p. 344

[69] IOR/E/4/640, 25 June 1793, pp. 513-14; IOR/E/4/643, 3 July 1795, p. 597; IOR/E/4/645A, 27 July 1796, p. 330; RSA, *Third Report of the Committee of Warehouses*, pp. 4-5.

The Company had to admit that the venture was far from successful and by 1808 was ready to abandon it.[70] The Court frequently complained that the quality of the raw silk imported from Bengal was not appropriate to be used in throwing mills. The silk was found to be too coarse, to break too frequently and to be difficult to work with.[71] Consequently, the quality of the organzine was considered sufficient only for the use in the ribbon industry.[72] There is no indication that the organzine was used in broad weaving.

Hence, the EEIC was unable to extend the use of Bengal raw silk because the silk was being used for throwing into trams and singles and then used in the ribbon trade and for production of small wares already before 1794. Bengal silk continued to be used for trams and singles even after the EEIC abandoned its throwing experiment. The evidence presented to the Select Committee on Silk Trade in 1832 shows that Bengal raw silk was used in Coventry and Lancashire.[73] It was found to be unfit for throwing it into organzine, yet suitable for the haberdashery.[74]

Overall, the plan of the EEIC to produce organzine failed because the Company underestimated the quality of the raw silk to be used for the production of organzine. Bengal raw silk did not possess the qualities required such as roundness and equality of threads, fineness, flexibility and strength. The Company also faced criticism from both contemporary political-economy writers and manufacturers who accused the EEIC of trying to secure a monopoly on silk throwing in Britain.[75] However, that was never the Company's goal. The EEIC got involved in silk throwing because it

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[70] LSE Archives, W7204, East India Company, *Reports and Documents*, p. xxix.

[71] RSA/SC/EL/2/31, *Third Report of the Committee of Warehouses*, pp. 6-7 and 11-14.

[72] Ibid.

[73] House of Commons, *Report from Select Committee on the Silk Trade*, pp. 41, 154 and 174.

[74] Ibid., pp. 207, 359, 360, 640 and 739.

[75] The most ardent critic was the anonymous writer of [G.L.], 1796 fol. 16654, *Considerations*, pp. 1-36.

considered it the only possible way to expand the consumption of Bengal raw silk in Britain. At the same time the Court in London was convinced that expanding silk throwing was risky and that private entrepreneurs were too risk-averse to get involved in the plan.

The Court pointed out the reasons for the actors involved in silk throwing to be risk averse to throw Bengal raw silk:

> The Proprietors of Mills in general, do not work them for hire: they are chiefly employed in working Silks of other Descriptions than Organzine, nor will they be tempted to enlarge their Works for new undertakings, without a reasonable Prospect of permanent Employment and suitable recompense for their Labours. The wholesale Dealers will also be diffident of making Purchases of the Raw Material at the Company's Sale, and getting it worked into Organzine unless they see to a certainty a reimbursement of their expenses, with at least the chance of some gain.[76]

The Company was prepared to bear short-term losses because it was convinced that the venture would prove to be successful. The Court was keen to stop its involvement in silk throwing once it became profitable and started to attract the interests of private entrepreneurs: "Our pursuits therein will of course cease, as We have no wish to benefit Ourself in a Commercial point of view beyond the mere advantages that will accrue from an extended Sale of the Raw Material".[77] Unfortunately, throwing Bengal raw silk into organzine in Britain never became profitable and never attracted the interest of domestic manufacturers.

[76] IOR/E/4/643, 3 July 1795, pp. 590-91.

[77] Ibid., p. 593.

## 4.4. Conclusion

I have shown that the adoption of the Piedmontese system of silk reeling enabled the Company to expand its silk trade. The Company was able to increase its share of total imports of raw silk into the British market from just over 8 percent prior to 1750-60 to over 40 percent on average during the period 1773-89. Owing to the improved quality of the filature-made silk the EEIC was able to capture a large share of the British market. However, the quality of the silk was still not sufficient for it to attain a price increase of around 25 percent per gr. lb as expected. As the demand for Bengal raw silk was also dependent on its quality by the late 1790s the market became overstocked. It was an unfortunate coincidence for the Company that the British silk industry was going through a phase of decline and stagnation at exactly the same time as the Company ventured into the Bengal silk industry. Nevertheless, the Company's efforts were undermined principally by the issues of quality rather than by the fluctuating demand for raw silk in Britain.

Issues with the quality of raw silk undermined also the Company's attempt to extend the consumption of Bengal raw silk by throwing part of it into organzine. In order to make the Bengal venture profitable in the long term, the Company hired throwing mills in England and throw the excess Bengal raw silk into organzine. Qualities of Bengal raw silk made it usable for throwing into trams and singles. Due to the inappropriate quality of the silk, the Company was unable to produce organzine of sufficient quality to substitute for imports of Italian organzine and had to abandon the project.

# CHAPTER 5

## Value Chain and Factor Prices in Bengal Filature Production

> It has been an object of much concern to us to find that notwithstanding the sums that have been sacrificed and so severely felt by the Company to the perfecting this Branch of our Investment, the Silk production in Bengal where labour is infinitely cheaper than in Italy should have a considerable loss whilst that from Italy gives a regular profit.[1]

A large body of literature focuses on factor-price ratios as determinants of technological paths. Factor prices are often seen as crucial for the success of technology transfers. Yurio Hayami and Vernon W. Rutan argue that the likeness of factor prices between the country where a technology originates and the country where that technology is imported is crucial for its profitability in the new environment.[2] Only a technology which makes use of a factor that is abundant while saving a factor that is scarce can be sustainable in the long term. Moreover, it is expected that the importation of such a technology enables further domestic adaptation.[3]

Economic history literature frequently cites factor prices as one of the main reasons why India did not adopt a factory system in the eighteenth and early in the nineteenth century. Arguably the EEIC's decision to implement a centralised system of production in raw silk manufacturing was therefore premature and thus the venture would be expected to be unsuccessful. However, silk reeling – due to the EEIC's

[1] IOR/E/4/628, 11 April 1785, p. 553.

[2] Yurio Hayami, Vernon W. Rutan, 'Factor Prices and Technical Change in Agricultural Development: The United States and Japan, 1880-1960', *Journal of Political Economy* 78 (5), 1970, pp. 1115-141.

[3] See H. J. Habakuk, *American and British Technology in the Nineteenth Century: The Search for Labour-Saving Inventions* (Cambridge: Cambridge University Press, 1967); William Fellner, 'Two Propositions in the Theory of Induced Innovations', *Economic Journal* 71 (282), 1961, pp. 305-8.

requirements for quality, labour costs, labour intensity and precision of reelers – represents in many ways a special case. This chapter adopts commodity- and value-chain approaches to analyse the profitability of the transfer of the Piedmontese technology to Bengal.[4] According to these concepts, firms gain advantage over their competitors by integrating production and gaining control over more stages of production within a certain commodity chain.[5] The approach also draws on development studies which postulates that developing countries – the majority of which are low-wage economies – need to adopt new technologies even if the initial cost is high.[6]

This chapter considers the initial cost of adopting the Piedmontese system. This cost was significant but history presents several cases when the adoption of a new technology was accompanied by significant initial outlays.[7] The chapter analyses the

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[4] Michael E. Porter, *Competition in Global Industries* (Boston: Harvard University Press, 1986), pp. 20-22; Id., ‘Changing Patterns of International Competition’, *California Management Review* 28 (2), 1986, pp. 9-40; Id., *The Competitive Advantage of Nations* (New York: Free Press, 1990), pp. 41-51.

[5] Porter, *Competition in Global Industries*, p. 19.

[6] Development literature often draws on arguments presented by Alexander Gerschenkron, *Economic Backwardness in Historical Perspective: A Book of Essays* (Boston: Harvard University Press, 1962). For a development studies approach see, for instance: Erich S. Reinert, *Why Rich Countries Got Rich and How Poor Countries Stay Poor* (London: Constable, 2007); Ha-Joon Chang, *Kicking Away the Ladder: Development Strategy in Historical Perspective* (London: Anthem, 2002); Justin Lin and Ha-Joon Chang, ‘Should Industrial Policy in Developing Countries Conform to Comparative Advantage or Defy it? A Debate Between Justin Lin and Ha-Joon Chang’, *Development Policy Review* 27 (5), 2009, pp. 482-502.

[7] Several examples are associated with the industrialization of Japan. For the silk industry see, for instance: Debin Ma, ‘Why Japan, Not China, Was the First to Develop in East Asia: Lessons from Sericulture, 1850-1937’, *Economic Development and Cultural Change* 52 (2), 2004, pp. 369-94; Yukihiko, Kiyokawa, ‘Transplantation of the European Factory System and Adaptations in Japan: The Experience of the Tomioka Model Filature’, *Hiotsubashi Journal of Economics* 28 (1), 1987, pp. 27-39. Examples can also be found in other European and Asian countries that industrialized during the so-called ‘second industrial wave’. It was often necessary to invest large sums in the first phase of industrialization, for an example see industrialization in Austria and Czech lands, see for instance: Richard L. Rudolf (ed.), *Banking and Industrialization in Austria-Hungary: The Role of Banks in the Industrialization of the*

cost of production of filature silk in Bengal and compares it to Piedmont. It argues that factor prices does not explain the ultimate failure in the transfer of the Piedmontese silk-reeling technologies to Bengal. On the contrary, the returns on investment analysis shows that the investment was profitable. Low labour costs in Bengal were advantageous in labour-intensive raw silk production. Moreover, the adoption of the centralised system of production led to improvements in the quality of Bengal raw silk and to increased productivity.

## 5.1. Factor Prices and Technological Changes in the Silk Industry

Factor prices are considered crucial for the success of technological transfers. As valuable as this theory is in explaining the profitability of the adoption of capital-intensive or labour-intensive technologies, it does not apply to the adoption of the filature system in Piedmont or Bengal. The theory cannot capture the specific conditions of the eighteenth-century silk industry.

In economics, factor prices have been studied in relation to international trade, innovation, the development and adoption of new technologies, and in relation to technology transfers.[8] When differences in factor prices are addressed in economic history literature, it is usually from the point of view of shifting competitive advantage. Authors such as Stephen Broadberry and Bishnuprya Gupta, E. Rothbarth, Robert Allen

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*Czech Crownlands, 1873-1914* (Cambridge : Cambridge University Press, 1976); Richard Sylla and Gianni Toniolo (eds.), *Patterns of European Industrialization: The Nineteenth Century* (London: Routledge, 1992).

[8] Research on factor prices is related to the study of economic globalization and integration. It follows the neoclassical trade theory approach and builds on the Heschker-Ohlin theory of international trade and on the Stolper-Samuelson theorem. This approach assumes that globalization leads to product price convergence which generates factor price convergence. Nick Harley, ‘Comments on Factor Prices and Income Distribution in Less Industrialized Economies, 1870-1939: Refocusing on the Frontier’, *Australian Economic History Review* 47 (3), 2007, pp. 238-44.

and Hayami and Ruttan have focused on how high wages facilitated the development and adoption of capital-intensive technologies associated with high labour productivity.[9] Robert Allen has explained that the Industrial Revolution took place in Britain because it was a high-wage economy and high wages facilitated a search for technologies that could substitute labour for capital.[10]

Whilst most of the discussion of the effects of factor prices on technological choices focuses on the United States and Britain in the nineteenth century, studies by Broadberry and Gupta bring a more global perspective to the diversity of factor prices in the seventeenth- and eighteenth-century world economy.[11] They argue that high wages

[9] Stephen Broadberry and Bishnuprya Gupta, 'Lancashire, India, and Shifting Competitive Advantage in Cotton Textiles, 1700-1850: The Neglected Role of Factor Prices', *Economic History Review* 62 (2), 2009, pp. 279-305. See also: E. Rothbarth 'Causes of the Superior Efficiency of USA Industry as Compared with British Industry', *Economic Journal* 56, 1946, pp. 383–90; Robert Allen, *The British Industrial Revolution in Global Perspective* (Cambridge: Cambridge University Press, 2009); Robert Allen, Jean-Pascal Bassino, Debin Ma, Christine Moll-Murata, and Jan Luiten van Zanden, 'Wages, Prices, and Living Standards in China, 1738–1925: In Comparison with Europe, Japan, and India', *Economic History Review* 64 (S1), 2011, pp. 8–38; Robert Allen, 'The High Wage Economy and the Industrial Revolution: A Restatement', *Economic History Review* 68 (1), 2015, pp. 1-22.

[10] Robert Allen considers macro-inventions decisive for industrial development and identifies James Hargreaves' spinning jenny (with Richard Arkwright's water frame) as key invention of Industrial Revolution. Allen argues that the invention of the spinning jenny was driven by factor supply conditions. Allen, *British Industrial Revolution*, pp. 182-216. However, the evidence collected by John Styles shows that spinning jenny was an "inexpensive, low-tech, mechanical enhancement to household-based spinning" therefore, Allen's argument that it was a labour-saving capital-intensive macro-invention cannot hold. John Styles, Fashion, Textiles and the Origins of the Industrial Revolution, (Paper Presented at the Conference: 'Anglo-Japanese Conference of Historian', Osaka, August 2015), pp. 3, 7-20 and especially 21. This undermines Allen's argument that factor prices are the sole factor driving technological development. In his book *The British Industrial Revolution in Global Perspective*, Robert Allen also gives importance to coal which gave Britain an important source of energy for the Industrial Revolution. Allen, *British Industrial Revolution*, pp. 80-106 and 135-156; see also Allen, 'High Wage Economy', p. 2.

[11] Broadberry and Gupta argue that wage rates in eighteenth-century India were significantly lower than in northwestern Europe and this facilitated differences in industrial development in these regions. Stephen

in Britain facilitated the adoption of capital-intensive production methods in the cotton industry. These new methods increased labour productivity and in turn shifted the international competitive advantage in cotton production to Britain. In India, on the other hand, comparatively low wages reinforced the focus on labour-intensive domestic cotton production.[12] In the pre-modern era, India was able to produce cotton textiles of superior quality for lower prices than other world cotton producers. India's competitive advantage in cotton production was grounded in superior knowledge of the finishing processes.[13] However, the adoption of the factory system and new machinery allowed Britain to increase the quality of its cotton production as well as to decrease the costs of production.[14]

The silk industry represents a rather specific case that might not support theories based on factor prices or conclusions drawn from the analysis of the cotton sector. A factory-type organization of production was adopted in silk manufacturing sooner than in other industries in response to the introduction of complex reeling technologies.[15] The profitability of the centralised system of production in the eighteenth-century silk industry was underpinned by specific factors: requirements for

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Broadberry and Bishnuprya Gupta, 'The Early Modern Great Divergence: Wages, Prices and Economic Development in Europe and Asia, 1500-1800', *Economic History Review* 59 (1), 2006, pp. 3, and 12-27.

[12] Broadberry and Gupta, 'Lancashire, India', pp. 281-82. For discussion of India as a high-wage economy see for instance: Parthasarathi, Prasannan, *The Transition to a Colonial Economy: Weavers, Merchants and Kings in South India* (Cambridge: Cambridge University Press, 2002), especially pp. 3-5 and 15-18.

[13] See Giorgio Riello and Tirthankar Roy (eds.), *How India Clothed the World* (Leiden: Brill, 2009); Prasannan Parthasarathi, 'Cotton Textiles in the Indian Subcontinent, 1200-1800', in Giorgio Riello and Prasannan Parthasarathi (eds.), *Spinning World: A Global History of Cotton Textiles, 1200-1800* (Oxford: Oxford University Press, 2009), pp. 17-42.

[14] Broadberry and Gupta, 'Lancashire, India', pp. 282-302.

[15] Claudio Zanier, 'Pre-Modern European Silk Technology and East Asia: Who Imported What?', in Debin Ma (ed.), *Textiles in the Pacific, 1500-1900. The Pacific World: Lands, Peoples and History of the Pacific, 1500-1900* (Aldershot: Variorum, 2005), pp. 131-39.

quality and the need to keep labour costs down. These factors made the centralised system indispensable for the production of high-quality silk.

The specific requirements of the silk industry concerning the quality of raw silk thus favoured the adoption of a centralised system of production. At the same time, access to cheap labour remained essential to the profitability of silk reeling. Therefore once the knowledge of sericulture and silk reeling became widely available, the cost of labour remedied the most important factor determining the spatial distribution of the silk industry.[16] It is therefore necessary to pay attention to both factor prices and knowledge of silk production when studying the development of the silk industry on a global scale.

The literature on the silk industry in the pre-modern period has focused predominantly on the development of new technologies and has generally neglected the role of factor prices.[17] Factor prices are important because factor supply conditions can make technologies too costly. The way in which silk production centres shifted across time supports this argument.[18] The conditions necessary for the successful development of the production of raw silk were complex. Both sericulture and silk reeling were

[16] Giovanni, Federico, *An Economic History of Silk Industry, 1830-1930* (Cambridge: Cambridge University Press, 1997), pp. 14-15.

[17] See for instance: Zanier, 'Pre-Modern European Silk Technology and East Asia', pp. 105-191; Richard Hills, 'From Cocoon to Cloth: The Technology of Silk Production', in Simonetta Cavaciocchi (ed.), *La Seta in Europa Secc. XIII-XX* (Prato: Istituto Internazionale di Storia Economica, 1993), pp. 59-90; Dieter Kuhn, 'Textile Technology: Spinning and Reeling', in Joseph Needham (ed.), *Science and Civilization in China: Chemistry and Chemical Technology* (Cambridge: Cambridge University Press, 1988), Vol. 5, Part 9; Carlo Belfanti, 'Guilds, Patents, and the Circulation of Technical Knowledge: Northern Italy during the Early Modern Age', *Technology and Culture* 45 (3), 2004, pp. 569-89.

[18] The main centres of raw silk production switched according to technological leadership as well as the competitive advantage produced by the low cost of labour. Cheap labour can explain the ascendency of Japan in the nineteenth century and East Asian countries in the twentieth century. Debin Ma, 'The Great Silk Exchange: How the World was Connected and Developed', in Ma (ed.), *Textiles in the Pacific*, pp. 54-55; Kazuko Furuta, 'Silk-Reeling in Modern East Asia: Internationalization and Ramifications of Local Adaptations: In the late 19th Century', in Ibid., pp. 191-203.

labour-intensive activities relying on cheap labour; the production of silk thread, on the other hand, additionally required sophisticated technologies.[19] Historical examples show that it was important to simultaneously have access to advanced technologies and to cheap labour. In this respect, the transfer of Piedmontese technologies to Bengal was advantageous.

The emergence of Piedmont as the European centre of production of high-quality raw silk and organzine was based on technological leadership as well as on favourable labour conditions. From the international perspective – especially in comparison to Britain – eighteenth-century Piedmont was a relatively low-wage economy.[20] While, the eighteenth century saw the rise of silk weaving industries in north-western Europe, Piedmont specialised in raw silk production. As both the French and British silk weaving industries were dependent on imports of raw materials, Piedmontese silk producers did not lack demand for their products.[21] Piedmont developed this industry by relying on long-term familiarity with raw silk production as well as on favourable climatic conditions.[22] However, to retain their competitive advantage, silk reeling and throwing activities in Piedmont moved from urban areas to the countryside in search of lower labour costs as early as the first part of the seventeenth century.[23] Claudio Zanier observed that constant technological innovation

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[19] Goldsmiths´ Library [G.L.], 1796 fol. 16654, *Considerations on the Attempt of the East-India Company to Become Manufacturers in Great Britain* (London: n.p., 1796), pp. 31-32.

[20] Robert Allen, 'The Great Divergence in European Wages and Prices from the Middle Ages to the First World War', *Explorations in Economic History* 38 (4), 2001, pp. 413–15; Robert Allen, 'High Wage Economy', pp. 7-8.

[21] Luca Molà, *Silk Industry in Renaissance Venice* (London: John Hopkins University Press, 2000), pp. 217 and 244; Roberto Davini, 'The History of Bengali Raw Silk as Interplay between the Company Bahadur, the Bengali Local Economy and Society, and the Universal Italian Model, c.1750 – c.1830', *Commodities of Empire Working Paper* 6 (2008), pp. 5-7.

[22] Davini, 'History of Bengali Raw Silk', p. 6.

[23] Ibid., pp. 6-8.

was crucial to retain a competitive advantage in the silk industry. However the shifting locations of the main production centres are also indicative of the important role played by labour costs.[24]

Raw silk production is a highly labour-intensive activity. In several cases transfers of silk reeling technologies failed due to high wages in the country where the technology was imported. For instance the transfer of reeling technologies to Georgia failed for this reason.[25] Moreover, even well-established production centres could not retain their position without cutting labour costs. Irrespective of the quality of the silk produced, high wages undercut competitive advantage. This caused the decline of silk production in Bologna in the eighteenth century. Carlo Poni blames the lack of institutional innovation and the constraints posed on relocation of raw silk production to the countryside for the decline of Bologna's raw silk production.[26] The importance of technologies and labour costs were well-understood by contemporary writers and traders. They were convinced that the lower labour costs in Bengal would give this region an undisputed advantage and that Bengal silk would easily conquer new markets.

The role of factor endowments in the transfer of silk technologies to Japan in the first half of nineteenth century was considered by Debin Ma and Yukihiko Kiyokawa. Debin Ma has argued that Japanese success in raw silk production was built on adapting the transferred technologies – applying new innovations and combining them with existing Japanese technologies.[27] The other important factor was that the

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[24] Zanier, 'Pre-Modern European Silk Technology and East Asia', p. 131.

[25] Ben Marsh, *Georgia´s Frontier Women: Female Fortunes in a Southern Colony* (London: University of Georgia Press, 2007), pp. 53-59.

[26] Carlo Poni, 'Comparing Two Industrial Districts: Bologna and Lyon in the Early Modern Period', in Pier Luigi Porta, Roberto Scazzieri, Andrew S. Skinner (eds.), *Knowledge, Institutions, and the Division of Labour* (Cheltenham: Edward Elgar, 2001), p. 211.

[27] Debin Ma, 'Why Japan, Not China', p. 370; Kiyokawa, 'Transplantation of the European Factory System', pp. 32-33.

factory system in silk reeling relied on the intensive use of labour and Japan had abundance of cheap labour. Ma's findings support the "induced innovation hypotheses" of Yurio Hayami and Vernon Ruttan. According to this theory, transfers of technologies conforming to factor endowments allow for further adaptations of the new technologies and lead to a sequence of innovations aimed at saving the limiting factor.[28]

Similarly to other industries, factor-price mechanisms were decisive for the profitability of different production systems. In the silk industry, the centralised system of production did not become profitable in the eighteenth century because it substituted labour for capital but instead because it gave merchant-entrepreneurs the opportunity to take full advantage of cheap labour. The aim was not to sweat labour but to impose quality control. Hence, even though the Piedmontese reeling machine constituted an important technological innovation, reeling remained a labour-intensive process and factory-type organization enabled the imposition of discipline and quality regulations.

## 5.2. The Value Chain of Bengal Raw Silk Production

It would be misleading to expect the EEIC to be in a position to perform a thorough investment analysis of the future returns on its investment. Eighteenth-century business and entrepreneurial practices were not characterized by advanced management and accounting systems.[29] The EEIC knew that labour in India was cheap and it also counted on preferential access to Bengal raw silk. Foremost, the Company expected to be able to produce higher-quality silk at competitive prices if it integrated reeling into its business operations. Adopting a centralised system of production made direct control

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[28] Hayami and Rutan, 'Factor Prices', p. 1115; Yurio Hayami and Vernon W. Ruttan, *Agricultural Development: An International Perspective* (Baltimore: John Hopkins University Press, 1985), p. 4.

[29] Sidney Pollard, *The Genesis of Modern Management: A Study of the Industrial Revolution in Great Britain* (London: Edward Arnold, 1965), pp. 190-3 and 250-70.

over silk reeling possible and allowed the Company to differentiate its product – Bengal raw silk – from other types of silk.

This section considers the role of commodity and value chains in shaping technology paths.[30] Integrating reeling into its business activities enabled the EEIC to manage a higher proportion of the global commodity chain in raw silk production and exports. A commodity chain is defined as "a network of labor and production processes whose end result is a finished commodity".[31] A global commodity chain "consists of sets of inter-organizational networks clustered around one commodity or product, linking households, enterprises, and states to one another within the world-economy".[32] Many industries were already characterized by global commodity chains in the pre-industrial period.[33] The silk industry was one of these due to the diffusion of silk weaving to regions with climatic conditions unfavourable to sericulture. Moreover, the global commodity chain in silk production was characterized by high levels of

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[30] Current changes in global commodity and value chains have significant effects on shaping the economies of many countries and have important social impacts. See for instance: Jennifer Bair and Gary Gereffi, 'Local Clusters in Global Chains: the Causes and Consequences of Export Dynamism in Torreon's Blue Jeans Industry', *World Development* 29 (11), 2001, pp. 1885-903; Jeff Neilson and Bill Pritchard, *Value Chains: Institutions and Governance in the Plantation Districts of South India* (London: John Wiley & Sons, 2011); Gary Gerrefi, 'International Trade and Industrial Upgrading in the Apparel Commodity Chain', *Journal of International Economics* 48 (1), 1999, pp. 37-70.

[31] Terence K. Hopkins and Immanuel Wallerstein, 'Commodity Chains in the World-Economy Prior to 1800', *Review Fernand Braudel Center* 10 (1), 1986, p. 159.

[32] Gary Gereffi, Miguel Korzeniewicz and Roberto P. Korzeniewicz, 'Introduction: Global Commodity Chains', in Gary Gereffi and Miguel Korzeniewicz (eds.), *Commodity Chains and Global Capitalism* (Westport: Praeger, 1994), p. 2.

[33] An example is early-modern shipbuilding: Eyüp Özveren, 'The Shipbuilding Commodity Chain, 1590-1790', in Gereffi and Korzeniewicz (eds.), *Commodity Chains and Global Capitalism*, pp. 20-34. "We think it is quite clear that for these two fundamental processes of the capitalist world-economy in the seventeenth and eighteenth centuries, the commodity chains were geographically extensive, complex, and in constant recomposition." Terrence Hopkins and Immanuel Wallerstein, 'Conclusions about Commodity Chains', in Gereffi and Korzeniewicz (eds.), *Commodity Chains and Global Capitalism*, p. 48.

competition in both raw silk production and the silk textiles market. According to Porter, a firm can succeed in a global industry only if it "manages linkages in a global commodity chain in an integrated and systemic fashion".[34] By implementing the Piedmontese system of reeling, the Company gained management control over another stage of the commodity chain. They also enabled a certain level of control over the quality and helped to differentiate Bengal silk from other types of silk on the market.[35] Figure 5.1 shows the stages of the raw silk commodity chain in Bengal. The implementation of the Piedmontese system enabled the Company to take control over the secondary stage and control the process of reeling. The EEIC already controlled the tertiary stage which consisted of transport, sales and marketing.

**Figure 5.1. Commodity Chain in Raw Silk Production in Bengal, 1770s-1830s**

| **Primary stage** | **Secondary stage** | **Tertiary stage** |
|---|---|---|
| **Controlled by peasants** | **Controlled by EEIC** | **Controlled by EEIC** |
| **Inputs:** Silkworm Eggs, Mulberry Leaves, Water, Peasant Labour, Land for Mulberry Cultivation and Cocooneries. | **Inputs:** Land for filatures, Filatures, Labour of Reelers, Supervision, Cocoons, Wood. | **Inputs:** Freight, Customs, Charges for warehouses, etc. |
| | **Product** | |
| Cocoons → | Reeled silk → | Bengal raw silk on British market |

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[34] Michael E. Porter, Changing Patterns of International Competition, in David J. Teece (ed.), *The Competitive Challenge: Strategies for Industrial Innovation and Renewal* (Cambridge, MA: Ballinger, 1987), p. 30.

[35] The Company did not have a full control over quality due to agency problems.

Porter has argued that in industries characterized by global competition, competitive advantage can be achieved by integrating activities on a world-wide basis.[36] Porter draws on a disaggregated view of the firm, which he has called a "value chain".[37] From this point of view a firm is a "collection of discrete activities performed to do business in its industry" and these activities are called "value activities".[38] Firms can gain competitive advantage either by focusing on product differentiation or by lowering their production costs.[39] From this point of view the EEIC focused its activities towards achieving product differentiation in the eighteenth century. Such an approach was based on the structure of the contemporary market in raw silk, in which silk of higher quality attained higher prices. Silk manufacturers and weavers did not seek raw silk of the lowest price but silk of suitable quality. In such a market, product differentiation was a source of competitive advantage because it enabled focus on a target market.

Figure 5.2 draws on Porter's definition of firm as a value chain and adds the concrete operations carried out by the Company in raw silk production. The primary "value activities" were cocoon procurement, reeling, warehousing and transport, advertising and the organisation of sale. I have estimated the cost of these activities, the figures represent the costs that the EEIC needed to incur for each activity for the production of 1sm. lbs. of raw silk.

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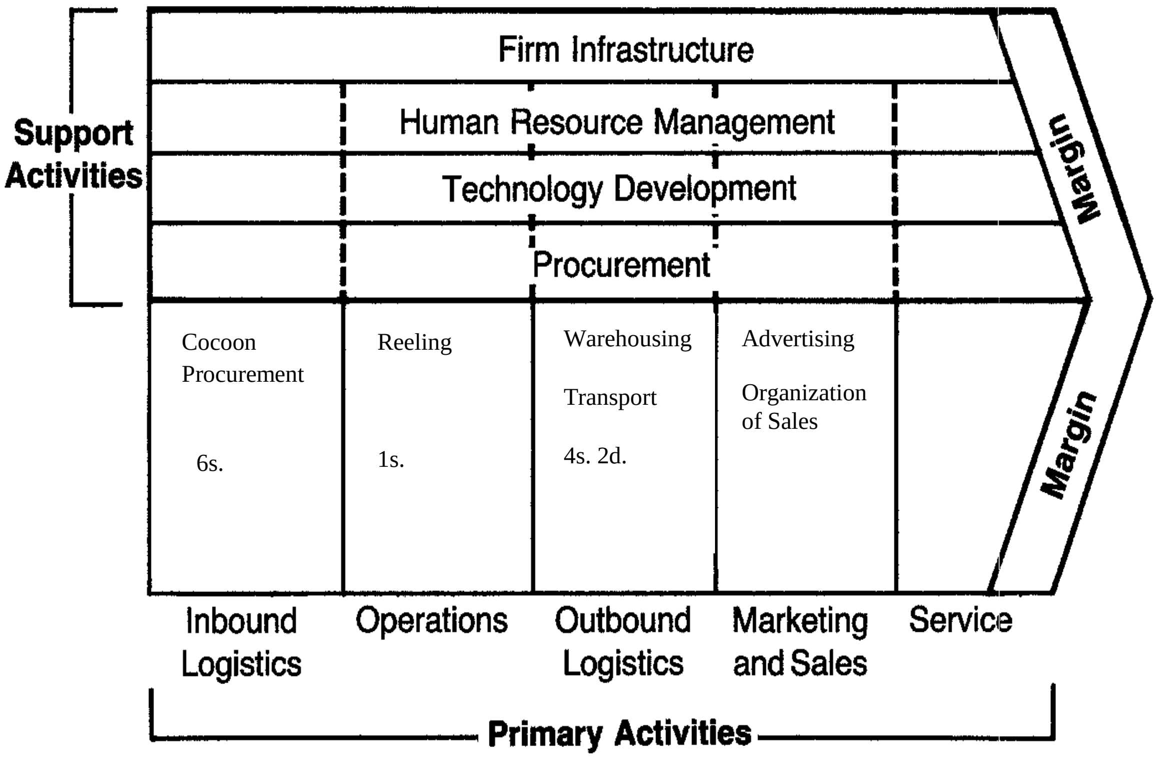
[36] Porter, *Competition in Global Industries*, p. 19.

[37] Porter, 'Changing Patterns', p. 13.

[38] Ibid., p. 13.

[39] A competitive advantage as defined by Porter is a "function of either providing comparable cost but in unique ways that create more buyer value than competitors and, hence, command a premium price (differentiation)". Ibid., p. 13.

**Figure 5.2. Value Chain in Bengal Silk Production**




*Source*: From Michael E. Porter. Changing Patterns of International Competition, *California Management Review*, 28 (2), 1986, p. 13. Costs are estimated for inputs necessary for producing 1sm. lbs. and for warehousing and transporting 1 sm. lbs. to Britain.

Porter distinguishes between two sources of competitive advantage: cheap labour and "higher order" competitive advantages (proprietary technology, product differentiation, brand reputation, customer relationships and constant industrial upgrading).[40] By implementing the Piedmontese system, the EEIC attempted to draw on two sources of "higher order" competitive advantages mentioned by Porter: product differentiation and brand reputation. The EEIC adopted the most advanced European reeling technology with the aim of producing 'Bengal Italian silk'. Their intention was to differentiate the silk from the other types and create a brand reputation for it.

[40] Porter, *Competitive Advantage of Nations*, pp. 49-51.

The case of the EEIC's raw silk production in Bengal illustrates the importance of transnational companies in shaping technological paths by increasing their control over global commodity chains. The decisions taken by transnational companies about the location of their business operations are based on factor endowments.[41] Decisions are often influenced by the "visible hand" of managers as well as by governments' actions.[42] Since commodity chains are internalized within the organizational boundaries of vertically-integrated firms, the governance structure of these corporations has a decisive role in allocating business activities to different geographical areas of a chain.[43] In the case of silk production in Bengal, it was the Court of Directors that represented the "visible hand", who had decisive influence on the development of the industry.

From the point of view of commodity-chain and value-chain theory, the adoption of a centralised system in the production of raw silk in Bengal does not seem misguided. The EEIC found that substantial changes in reeling practices were needed if the quality of Bengal raw silk was to improve and that measures of quality improvement were impossible to implement under the existing putting-out system. Improvements were possible only by attaining higher levels of control over the production process. Thus, even though the adoption of a factory-type system in eighteenth-century India has been considered premature, the actual circumstances of the silk industry present a case in which its adoption was rational. Silk reeling remained however a labour-intensive

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[41] However, this is not always to the same extent that the theory would predict. Pankaj Ghemawat, 'Competition and Business Strategy in Historical Perspective', *Business History Review* 76 (1), 2002, pp. 38-40.

[42] Alfred D. Chandler Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA: Harvard University Press, 1977), pp. 1-13; Atul Kohli, *State-Directed Development: Political Power and Industrialization in the Global Periphery* (Cambridge: Cambridge University Press, 2004), pp. 8-9 and 12-16.

[43] Alfred D. Chandler Jr., *Scale and Scope: The Dynamics of Industrial Capitalism* (Cambridge, MA: Harvard University Press, 1990), pp. 3-47.

industry relying on cheap labour. By integrating reeling into the value chain, the EEIC attained a stronger position than its competitors on the local market and the Company gained higher levels of control over the quality of Bengal raw silk.[44]

## 5.3. Prices of Inputs and Costs of Production of Bengal Filature Silk

The literature on silk production and transfers of silk technologies pays little attention to factor prices. This section analyses the costs of production of Bengal filature silk and factor endowments in the Bengal silk industry and compares them to Piedmont. The EEIC did not possess estimates of the prospective costs of producing filature-reeled silk in Bengal or the actual estimates for Piedmont. The expectation that the adoption of the filature system would be profitable was based on the fact that labour costs in Bengal were significantly lower than in Piedmont. Although labour was only one of the inputs, this analysis shows that the other inputs were cheaper in Bengal than in Europe.

Several documents allow us to consider the costs of filature silk production.[45] Table 5.1 shows the breakdown of production costs and reveals that cocoons were the most expensive input in the production of filature silk. Cocoons accounted for over 85 percent of total production costs. All other items of expenditure in production were therefore small and comprised charges for fuel, reelers' wages and sundry petty charges. Labour costs represented a low share of the total costs. Similarly the cost of the wood necessary as fuel for the furnaces which boiled water in basins was modest. Overall, producing one sm. lbs of reeled silk in Bengal cost the Company 7s. It is not clear whether the EEIC included costs such as the wages of overseers, silk specialists and

[44] Roberto Davini points out that the EEIC faced competition from local merchants in silk procurement throughout the eighteenth and nineteenth century. Roberto Davini, 'Una Conquista Incerta. La Compagnia Inglese delle Indie e la Seta del Bengala, 1769-1833' (Unpublished PhD: European University Institute, 2004), pp. 10-54.

[45] IOR/E/4/630, 12 April 1786, p. 390; IOR/E/4/637, 6 May 1791, p. 429.

directors of filatures under sundry petty charges.[46] However, such costs would not dramatically change the overall costs incurred. Other charges included the cost of freight, Customs and other charges – such as warehousing (Table 5.1). Hence, the total costs of 1 sm. lbs of silk, before it could be sold on the British market, amounted to 11s. 2d.

**Table 5.1. The Costs of Production of 1 sm. lbs. of Filature Silk, 1786**

| **Production Costs** | | % Total Production Cost |
|---|---|---|
| Cocoons | 6s. | 85,7% |
| Wages of Reelers | 6.8d. | 8.1% |
| Wood | 3.7d. | 4.4% |
| Sundry Petty Charges | 1.5d. | 1.8% |
| **Total Production Costs** | **7s.** | 100% |
| | | |
| **Additional Costs** | | % Overall Cost |
| Custom | 3s. | 26.9% |
| Freight | 7d. | 5.2% |
| Charges on Merchandize | 7d. | 5.2% |
| **Total Additional Costs** | **4s. 2d.** | 37.3% |
| | | |
| **Overall Costs** | **11s. 2d.** | |

*Source:* IOR/E/4/630, 12 April 1786, p. 390; IOR/E/4/637, 6 May 1791, p. 429.

It is important to compare these costs with the costs of producing reeled silk in Piedmont. Table 5.2 shows that cocoons were approximately three times more expensive in Piedmont than in Bengal. Similarly, daily wages of reelers were approximately three times higher in Piedmont (9d.) than in Bengal (3d.). However, such data does not tell us much about labour productivity. From the comparison of the costs

[46] It is not entirely clear which charges were put into the category "sundry petty charges". It can be expected that they included the wages of non-reelers and costs of running filatures.

of reeling 1 sm. lbs. of cocoons into filature-reeled silk, it is apparent that significantly more labour was needed in Bengal than in Piedmont (Table 5.2). Labour represented a higher share of the total cost of reeling in Bengal (18.4 percent versus 9.7 percent in Piedmont); however the lower cost of cocoons was an important factor which offset lower labour productivity. Therefore, the reeling of one sm. lb. of filature silk – when both reelers' wages and costs related to cocoons are included – was still almost three times cheaper in Bengal than in Piedmont.

**Table 5.2. Cost of Inputs in Piedmont and Bengal, 1780s**

| | Piedmont | | Bengal | |
|---|---|---|---|---|
| | d. | % Total | d. | % Total |
| Cost of Cocoons (1 sm. lbs.) | 13.0 | 90.3 | 4.0 | 81.6 |
| Cost of Reeling 1 sm. lbs. of Cocoons (Reeler Wage) | 1.4 | 9.7 | 0.9 | 18.4 |
| **Costs of Reeling 1 sm. lbs of Cocoons (Reeler Wage + Cocoons)** | 14.4 | 100 | 4.9 | 100 |

*Source*: IOR/E/4/630, 12 April 1786, p. 390; Giuseppe Chicco, *La Seta in Piemonte 1650-1800: Un Sistema Industriale D'Ancien Regime* (Milano: Franco Angelli, 1995), pp. 212-13 and 264.

Overall, the data shows that if one considers the prices of inputs, Bengal had favourable conditions for silk thread production.[47] Bengal's advantage was based not only on cheap

[47] When assessing the influence of factor endowments on the adoption of Piedmontese technologies in Bengal, it is important not to confuse the impact of factor conditions in sericulture and silk reeling. The evidence presented by Roberto Davini implies the presence of different factor endowments in sericulture in Bengal and Italy. However, differing factor endowments in sericulture would not negatively affect reeling unless they resulted in a shortage of cocoons for filatures or made cocoons in Bengal significantly more expensive than in Italy. It is important to acknowledge this since the sericultural conditions differed in both countries. Sericulture in Bengal was a labour- and land-intensive activity requiring the best land and entire peasant families were involved in it. In Italy, sericulture was a less intensive activity and it could be much more easily combined with other activities. The most significant difference between sericulture in Italy and Bengal was in the level of control of peasants by merchant-entrepreneurs. In Italy merchants decided the price at which they would purchase cocoons from peasants rather than buying them at a market price. The price that Piedmontese merchants paid for cocoons reflected the demand for

labour but also, and more importantly, on the price of cocoons. Although the Court of Directors and the Board of Trade complained on several occasions about the rising price of cocoons, their price never undermined the profitability of silk reeling. The cocoon prices remained relatively stable in the second half of the eighteenth century; the real issue was instead their supply and quality.[48] This does not, however, mean that access to cocoons was never a problem for the Company. Bad weather and natural disasters reduced the supply of cocoons on several occasions.[49]

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silk thread on the international market. The EEIC, on the other hand, was a price taker. It did not have the power to coerce peasants. First, the EEIC did not deal directly with peasants but relied on merchant agents for the procurement of silk who often set the price according to their interests. Moreover, peasants could sell cocoons on local markets. Thus, factor prices were not the only factor affecting sericulture. Freedom of contract, enforceability of contracts and delegating authority for the procurement of cocoons played a similarly important role. Davini, 'History of Bengali Raw Silk', p. 8; Giorgio Riello, *Cotton: The Fabric that Made the Modern World* (Cambridge: Cambridge University Press, 2013), pp. 62-64; Bishnupriya Gupta, 'Competition and Control in the Market for Textiles: Indian Silk Weavers and the English East India Company in the Eighteenth Century', in Giorgio Riello and Tirthankar Roy (eds.), *How India Clothed the World: The World of South Asian Textiles, 1500-1850* (Leiden: Brill, 2009), pp. 292-97; Roberto Davini, 'Bengali Raw Silk, the East India Company and the European Global Market, 1770-1833', *Journal of Global History* 4 (1), 2009, p. 59; Molà, *Silk Industry*, p. 226. For references in primary sources see also Goldsmiths´ Library [G.L.], 1775 fol.: George Williamson, *Proposals Humbly Submitted to the Consideration of Court of Directors for Affair of the United Company of Merchants of England Trading to the East Indies: For Improving and Increasing the Manufacture of Silk in Bengal* (London, s.n., 1775), pp. 14; IOR/E/4/630, 21 July 1786, pp. 548; Atkinson as cited in J. Geoghegan, *Some Account of Silk in India, Especially of the Various Attempts to Encourage and Extend Sericulture in that Country* (Calcutta: Department of Revenue and Agriculture, 1872), p. 7.

[47] IOR/E/4/630, 21 July, 1786, p. 549; IOR/E/4/640, 25 June 1793, p. 512. See also: Davini, 'Bengali Raw Silk', pp. 63-66.

[48] It has been argued by Roberto Davini that the main problem the EEIC faced was inadequate access to cocoons and their high price. In his thesis, Davini cites several examples of the complaints lodged by the Board of Trade about the dearness and rising prices of cocoons. Quantitative evidence, however, shows that the price of cocoons was in reality very favourable. The complaints should not be considered as evidence of the high price of cocoons but instead as evidence that the Company tried to procure cocoons at the lowest prices possible. Davini, 'Una Conquista Incerta', pp. 129-135.

[49] According to Davini external events such as the famine in Bengal in 1769-70 and the Maratha raids of the 1740-50s significantly changed factor supply conditions. Both of these events led to a depopulation of

Moreover, such events had also an impact on the price of cocoons on the local market. However, apart from the occasional surge of prices due to natural hazards, the price of cocoons did not change significantly in the 1770s or 1780s and oscillated around 5 Sicca Rupees and 6 Annas (11s. 8d.) per Seer (1.88 sm. lbs.).[50] The Court in London observed that "the price of Cocoons may be affected from accidental causes such as a scarcity of Crop, but we understand it has not undergone any very essential alteration for some years past".[51] The EEIC also tried to facilitate an increase in the supply of cocoons by decreasing taxation on land under mulberry cultivation.[52] The principal problem was the system of cocoon procurement because it depended on agents (called Pykars).[53] Pykars often sold cocoons to the Company's filatures at much higher prices than they bought them from peasants. Pykars often forced peasants to sell the

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Bengal. Although these events indisputably had negative effects on the amount of labour available, shortage of labour was not considered by the Court as a long-term problem. Depopulation and natural catastrophes had by curtailing the supply of cocoons on several occasions a negative impact on the quantity of Bengal raw silk imported into Britain. Davini, 'The History of Bengali Raw Silk', p. 8; Davini, 'Bengali Raw Silk', pp. 63-66; Davini. 'Una Conquista Incerta', pp. 33-34 and 53. However, trade data does not support the supposition that such events had long-term effects on the silk trade. Also the reports of silk specialists sent from Bengal to London imply that labour shortages were not a long-term issue or that they had a negative impact on reeling. Rather than complaining about shortage of labour, the silk specialists pointed instead to the benefits of the new system of reeling. "After the great mortality in Bengal in the year 1770 it was impossible for the Company to form any hopes of augmenting their investment in Silks. This augmentation however took place by the introduction of spinning after the Italian method". [G.L.], 1795 fol. 16280, *Reports of the Committee of Warehouses*, p. 18; IOR/E/1/61 ff. 486-487v: 18 Nov 1777: 'Letter 240 James Wiss in London to the Court Outlining the Advantages of the Indian Method of Spinning Silk in Bengal', p. 487; IOR/E/4/630, 21 July, 1786, p. 549; IOR/E/4/640, 25 June 1793, p. 512.

[50] Seer was a unit of weight commonly used throughout India. In Bengal 40 Seers equalled one Maund and one Maund equalled 75 sm. lbs., thus one Seer was approximately 1.88 sm. lbs.

[51] IOR/E/4/630, 21 July, 1786, p. 549.

[52] IOR/E/4/619: 'Cultivation of Mulberry, 17 March 1769', p. 334; IOR/E/4/623: 'Growth of Mulberry Plant Encouraged, 24 December 1776', p. 286.

[53] Occasionally the prices would increase due to a shortage of cocoons caused by natural hazards. IOR/E/4/630, 21 July, 1786, p. 548.

cocoons at a price that was below the market value.[54] Although the sums lost in this way were not high enough to have a considerable impact on filature production, the behaviour of Pykars undermined the interest of peasants to sell cocoons to the Company.

Wood and labour were also important inputs, but they were not considered scarce or expensive. The Court was concerned more about the quality and availability of wood than its price.[55] Several silk districts of Bengal lacked access to adequate supplies of wood, which undermined the production capacity of filatures. Moreover, green wood was used with detrimental effects on the quality of the produced silk.[56] Similarly labour costs were never considered to be excessive by the Court, their sole concern was the quality of reeling and the supply of reelers.[57]

The Company would very probably not have been able to procure raw silk at cheaper prices than it was able to produce it. Table 5.3 shows the prices at which the EEIC bought raw silk in 1765-71 before the adoption of the Piedmontese system. If the average prices at which the EEIC bought one sm. lbs. of silk from intermediary merchants are compared with the cost of producing one sm. lbs. in filatures, it is apparent that the EEIC was able to produce silk more cheaply in filatures than to

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[54] IOR/E/4/630, 21 July, 1786, pp. 548-50.

[55] Green wood did not produce enough heat to warm the water basins to the temperature necessary for reeling. IOR/E/4/625, 9 April 1777, pp. 187-89.

[56] Some of the silk districts did not have access to as much wood as was needed during the reeling season. The problem was most serious in the filatures in the districts of Kasimbazar, Ragnagatti, and Boalia. The filatures in Kasimbazar and Boalia even competed with each other for wood. Davini, 'Una Conquista Incerta', pp. 237-41.

[57] The directors of filatures frequently complained about limited supply, fluctuations in the number of reelers and the necessity of re-training them at the beginning of each season. However, similar complaints were not uncommon in the early days of the factory system. Moreover, the Company never considerably increased the wages of reelers, and was still able to attract sufficient labour. For complaints from manufacturers, see: Pollard, *Genesis of Modern Management*, pp. 160-240.

procure it from intermediary merchants. Whereas the costs of producing silk in filatures in the 1780s was 7s., the Company had to pay on average 9s. 10d. for one sm. lbs. of reeled silk when procuring it from intermediary merchants in the period 1765-7.

**Table 5.3. Comparative View of the Prices at which the EEIC Bought Raw Silk, 1765-1771**

| | In shillings and pence for sm. lbs of reeled silk | | | | | | |
|---|---|---|---|---|---|---|---|
| **Region** | **1765** | **1766** | **1767** | **1768** | **1769** | **1770** | **1771** |
| **Guzerat** | 9s. 6d. | 9s. 2d. | 8s. 2d. | 9s. 2d. | 9s. 6d. | 11s. 4d. | 11s. 6d. |
| **Tannah** | 9s. 6d. | 9s. 2d. | | 8s. 7d. | 10s. 7d. | 11s. 6d. | 11s. 11d. |
| **Poddapor** | 7s.11d. | 8s. 1d. | 7s. 9d. | 8s. 5d. | 8s. 8d. | 11s. 4d. | 11s. 6d. |
| **Commercolly** | 6s. 7d. | 7s. 5d. | 6s. 8d. | 6s. 7d. | 7s. 3d. | 11s. | 11s. 2d. |
| **Rungpore** | 6s. 9d. | 10s.1d. | 5s. 9d. | 8s. 7d. | 9s. 2d. | 10s. 11d. | 11s. 1d. |
| **Jungepore** | | | 11s. 6d. | 11s. 9d. | 12s. 5d. | 11s. 4d. | 11s. 6d. |
| **Mean Price** | 8s. | 8s. 9d. | 5s. 8d. | 8s. 10d. | 9s. 7d. | 11s. 3d. | 11s. 5d. |
| **Mean Price of 1 sm. lbs. of Reeled Silk, 1765-71** | | | | | | | **9s. 10d.** |
| **Wound from Pod** | | 19s. 6d. | 19s. 6d. | 19s. 6d. | 19s. 6d. | 12s. 11d. | |

*Source*: IOR/E/4/630, 21 July, 1786, p. 561. Before the adoption of filature system, "raw silk wound from Pod" was a term used to describe raw silk reeled under the Company's facilities and supervision. It was only an experimental production. IOR/E/4/616: 'Bengal Raw Silk to be Investigated by Richard Wilder, Bengal Supplement 25 March, 1757', pp. 656-57.

## 5.4. Bengal Silk Production and the Centralised System of Production

The adoption of the Piedmontese system required the implementation of a factory-type organisation of production. Based on factor-price theory, the literature considers the adoption of the factory system in eighteenth-century India as premature.[58] I disagree, the adoption of the centralised system in the Bengal silk industry was not premature because the investment made use of cheap inputs and was not capital intensive. This section analyses returns to investment in order to assess the profitability of the adoption

[58] Broadberry and Gupta, 'Lancashire, India', pp. 279-305.

of the Piedmontese system in Bengal. My analysis shows that the investment was profitable for the Company.

The factory system of the organization of production is generally associated with the Industrial Revolution. It changed the system of organization of labour, production techniques and introduced strict discipline and supervision of labour. Several theories explain the emergence of the factory system. Some of them draw on agency problems and transaction costs.[59] Other theories argue that factories emerged when the technologies and machines necessary for production required a significant capital outlays and entrepreneurs needed to ensure their efficient use.[60] Factory production was said to create benefits through specialization and efficient production.[61] Another strand maintains that factories were tools to extract the highest possible labour effort.[62] In Bengal, silk reeling factories became tools for the implementation of new reeling practices and for increasing the quality of output.

The adoption of new technologies and new practices of organization always necessitates considerable capital investment. The issues are when do such technological changes become profitable and when does the invested capital bring returns? Would the adoption of the factory system in eighteenth-century India be unprofitable under all

[59] Sanford J. Grossman and Oliver D. Hart, ‘The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration’, *Journal of Political Economy* 94 (4), 1986, pp. 691-719; Oliver E. Williamson, ‘The Theory of the Firm as Governance Structure: From Choice to Contract’, *Journal of Economic Perspectives* 16 (3), 2002, pp. 171-95; Id., ‘The Organization of Work: A Comparative Institutional Assessment’, *Journal of Economic Behaviour and Organization* 1 (1), 1980, pp. 5-38.

[60] Gregory Clark, ‘Factory Discipline’, *Journal of Economic History* 45 (1), 1994, pp. 128-63; Pollard, *Genesis of Modern Management*, pp. 181-92.

[61] David Landes focuses on the benefits created by breaking down production into tasks and assigning these tasks to workers according to their abilities and paying them accordingly. David Landes, ‘What Do Bosses Really Do?’, *Journal of Economic History* 46 (3), 1986, pp. 585-623.

[62] Stephen A. Marglin, ‘What Do Bosses Do? The Origins and Functions of Hierarchy in Capitalist Production’, *Review of Radical Political Economics* 6 (2), 1974, pp. 61-63 and 70-73.

conditions? Broadberry and Gupta asked whether the Indian cotton industry "was acting rationally" when it did not adopt the factory system.[63] They argue that the technological changes that occurred in British cotton manufacturing in the eighteenth century were facilitated by favourable factor endowments. India, on the other hand, was unable to adopt the same technologies because it was not a high-wage economy and capital was more expensive than in Britain. Hence, India continued to rely on household production.[64] Although this argument fits the induced innovation hypothesis, it does not explain the case of the adoption of the Piedmontese system in Bengal.

Factor-price theory can only explain whether a macro-invention would be profitable under certain factor endowments. It does not take into account that technologies develop and are adapted, and that the environment in which they operate is shaped by factors other than factor prices. Historically, technological paths have been shaped by factors such as micro-inventions, the political economy, markets, and business strategies of transnational companies: these factors are key to making new technologies profitable. First, adaptations have always played a central role in the successful adoption of technologies. Even macro-inventions could be adapted to fit specific factor supply conditions.

History offers several examples of small incremental changes steering technological paths. Even if such changes are slow, they still have profound effects on technological development. One such example is the Jacquard loom: it was invented by Joseph-Marie Jacquard in 1801 but it drew on a series of weaving machinery

[63] Broadberry and Gupta, 'Lancashire, India', p. 300.

[64] Ibid., pp. 300-4.

inventions.[65] Adaptations of sericulture and silk reeling to factor-supply conditions were equally decisive for making Japanese raw silk production successful.[66]

Another issue to consider is the influence of the political economy environment on the adoption of technologies. The political economy can have a decisive impact on technological development by creating institutions, aiding or thwarting innovations or by actively facilitating technological change. For instance, Tirthankar Roy shows in the case of India that technological paths can also be determined by the realm of social institutions, moral codes and social conventions.[67] Numerous examples illustrate the role of import substitution policies in facilitating the development and adoption of technologies before and after the Industrial Revolution. In many cases governments were directly involved in aiding industrial development.[68] This approach was advocated by Alexander Gerschenkron who encouraged governments' active involvement in the development of less advanced economies.[69] Following Gerschenkron, several authors

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[65] The Jacquard loom represented a milestone in the upgrading of weaving techniques because it mechanized the drawboy's task. The Jacquard mechanism enabled the weaver to operate the loom and select patterns without the need to rely on an assistant. Hills, 'From Cocoon to Cloth', p. 83-87. Another example is the Arkwright water frame that made possible the production of economically viable high-quality warp yarns in the late eighteenth century. Although invented by Richard Arkwright, the frame drew on a series of inventions that preceded it. John Styles pointed to the fact that this invention was not driven by factor supply conditions but that it aimed to solve the problems with quality and supply of warp in the European luxury textile manufacturing. Styles, Fashion, Textiles and the Origins, pp. 22-29.

[66] Ma, 'Why Japan, Not China', pp. 369-94; Kiyokawa, 'Transplantation of the European Factory System', pp. 27-39.

[67] Roy argues that factor prices do not offer compelling evidence for technological diversity. He claims that technologies driving the Industrial Revolution in the cotton industry did not emerge in India due to a lack of access to complementary skills necessary for the creation of capital goods rather than India's factor endowments. Indian social institutions imposed high transaction costs on knowledge transmission and precluded innovation. Tirthankar Roy, 'Knowledge and Divergence from the Perspective of Early Modern India', *Journal of Global History* 3 (3), 2008, pp. 361-62, 366, 374 and 386.

[68] See for instance: Reinert, *Why Rich Countries Got Rich*, pp. 21-100; Chang, *Kicking Away the Ladder*, pp. 19-53; Kohli, *State Directed Development*, pp. 27-54.

[69] Gerschenkron, *Economic Backwardness*, pp. 5-29.

point out that developing countries are predominantly low-wage economies, yet these countries still need to upgrade the technological base of their economies if they are to develop.[70]

Furthermore, the characteristics of markets play a similarly important role in shaping technological paths. Highly developed capital-goods industries can create motivational pressure to adopt new technologies. Nathan Rosenberg notes that machine producers in the United States in the nineteenth century were successful at creating mutual relationships by exchanging information and through effective communication between machinery producers and final goods producers.[71] The consequence was that goods producers learnt to adopt the technologies offered to them by machinery suppliers and machinery producers were able to eliminate customer preferences for tailored products and to standardise machinery. Besides pressure from producers of intermediary goods, customer tastes can also have significant influence on decisions about the adoption of technologies. In Britain, customer preferences for specifically tailored products in industries such as gun making and textile manufacturing overrode the pressure for the standardization of production of machinery. Rosenberg focuses on the civilian market for guns in nineteenth-century Britain. He shows that the use of machine technology in gun manufacturing was precluded by the English preference for hand-manufactured guns.[72]

Lastly, the business strategies of transnational companies and the "visible hand" of managers need to be considered as well. Alfred D. Chandler has shown that for

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[70] Chang, *Kicking Away the Ladder,* pp. 1-12 and 59-68; Kohli, *State Directed Development* pp. 8-9 and 12-16; Lin and Chang, 'Should Industrial Policy', pp. 495-500. These authors mostly advocate that developing countries should follow their competitive advantage when upgrading their technologies.

[71] Nathan Rosenberg, 'Economic Development and the Transfer of Technology: Some Historical Perspectives', *Technology and Culture* 11 (4), 1970, pp. 566-68.

[72] Rosenberg, 'Economic Development', pp. 558-59.

industries in which economies of scale and scope represented a competitive advantage, the "visible hand" of managers practically replaced the invisible hand of market.[73] Chandler's analysis focuses on nineteenth-century America, where mass markets encouraged large-scale investment and improved access to capital and credit made such investment possible. In many cases the adoption of new technologies and new types of organization of labour were cases of "trial and error" and the adoption of new technologies was not based on detailed analysis of factor endowments.

Thus assessing technological choices is a complex task: variables other than factor prices shape the profitability of new technologies. Assessing the case of Bengal only through the lens of factor prices would therefore be inadequate. The decision to adopt new technologies was taken by the Court of Directors, hence one can see the 'visible hand' of managers driving decision-making processes. Moreover, these decisions were based on intuition rather than on investment analysis.

In the previous section I have shown that the adoption of the filature system did not increase the costs of silk thread production. In fact, the EEIC was able to reel silk in filatures at lower costs than it was able to procure the silk from intermediary merchants. Yet, one must also consider the initial cost of adopting the Piedmontese system. To assess the profitability of the investment I use a simple model calculating returns on investment (Table 5.4). The return on investment (ROI) is a commonly used measure of profitability. It shows the financial performance of a firm and enables informed

[73] Chandler Jr., *Visible Hand*, pp. 1-13.

management decisions about investment.[74] ROI is the ratio of "net profits over the investment needed to generate the profits".[75]

$$\text{ROI} = \frac{\text{Profit}}{\text{Investment}}$$

ROI only provides information about profitability over a specific period; therefore my analysis also calculates the Net Present Value (NPV) and the Internal Rate of Return (IRR) – measures commonly used to determine profitability of multi-period projects.[76] NPV is the "present (discounted) value of future cash inflows minus the present value of the investment and any associated future cash outflows".[77] NPV in other words is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. NPV is commonly used in economics, finance and accounting to assess the profitability of investment – negative NPV denotes loss while positive NPV means that the investment is profitable: The NPV is calculated by:

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0$$

In which $C_t$ is net cash inflow during the period, $C_0$ initial investment, *r* discount rate, and *t* number of time periods.

IRR is the "percentage return on the investment over a period of time".[78] IRR is also used for evaluating investment and is the discount rate at which the present value of

[74] Robert Rachlin, *Return on Investment Manual: Tools and Applications for Managing Financial Results* (New York: M. E. Sharpe, 1997), pp. 3-8.

[75] Paul W. Farris, Neil T. Bendle, Phillip E. Pfeifer and David J. Reibstein, *Marketing Metrics: The Definitive Guide to Measuring Marketing Performance* (New Jersey: Pearson Education, 2010), p. 338.

[76] Ibid., p. 337.

[77] Ibid., p. 346.

[78] Ibid., p. 348. IRR is also referred to as the discounted cash flow rate of return, rate of return, internal yield, marginal efficiency of capital, and the investor method. M. A. Mian, *Project Economics and Decision Analysis: Volume 1 Deterministic Models* (Tulsa: PennWell Corporation, 2010), p. 316.

future cash flows is equal to the initial investment. The higher the IRR the more desirable it is for a company to invest in a project.

The model includes data on the cost of setting up a filature, operational costs (the cost of producing one sm. lbs. of silk, including charges for merchandize, freight, and customs), the prices of silk on the British market, and the quantity of silk produced by the filature. The figures for the quantity of filature silk produced in a filature and setting up costs used in the model are based on data for the Kasimbazar filature (a filature with 208 furnaces). The price of the Bengal filature silk on the British market denotes the average price for which one sm. lbs. sold. It was not possible to ascertain the figure for a specific filature. The figure for operational costs is based on calculations in Table 5.1. Total cost equals the operational costs (or the costs of producing one sm. lbs. of silk) multiplied by the quantity of produced silk.[79] Revenue is the quantity of silk produced in a year multiplied by the price of filature silk on the British market. The total cash inflow is calculated as the revenue minus the total costs including setting up costs. The Internal Rate of Returns (IRR) on profit streams in the period 1772-79 was 55 percent. The NPV for investment into filatures in Bengal is positive both with a 10 percent discount rate (NPV 1) and a 5 percent discount rate (NPV 2). The NPV remains positive even for a 15 percent and 20 percent discount rate. This shows that the investment was highly profitable (Table 5.4).

[79] The data used comes from a filature set up by James Wiss in Kasimbazar. The only exception is the price data, these are mean prices.

**Table 5.4. Returns on Investment in Silk Filatures, 1772-1779**

| Year | 1772 | 1773 | 1774 | 1775 | 1776 | 1777 | 1778 | 1779 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **Quantity of Filature Silk Produced in a Filature (sm. lbs.)** | | 20,565 | 20,565 | 20,565 | 20,565 | 20,565 | 20,565 | 20,565 |
| **Price of Bengal Filature Silk on the British Market (£)** | | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| **Costs** | | | | | | | | |
| **Setting up costs (£)** | 10,774 | | | | | | | |
| **Operational Costs (£) = Costs of Producing 1sm. lbs. of Filature Silk** | | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| **Total Cost (£) = Quantity * Operational Costs** | | 12,339 | 12,339 | 12,339 | 12,339 | 12,339 | 12,339 | 12,339 |
| | | | | | | | | |
| **Revenue (£) = Price * Quantity** | | 18,509 | 18,509 | 18,509 | 18,509 | 18,509 | 18,509 | 18,509 |
| | | | | | | | | |
| **Total Cash Inflow (£) = Revenue – Total Cost – Setting up Cost** | (10,774) | 6,170 | 6,170 | 6,170 | 6,170 | 6,170 | 6,170 | 6,170 |
| **IRR (%)** | 55% | | | | | | | |
| **NPV 1 (£) – 10% discount rate** | 17,511 | | | | | | | |
| **NPV 2 (£) – 5% discount rate** | 12,405 | | | | | | | |

*Source*: IOR/E/4/625, 9 April 1779, pp. 131-32; IOR/E/4/630, 12 April 1786, p. 390; IOR/E/4/637, 6 May 1791, p. 429.

The sums invested to adopt the filature system in Bengal were substantial. The EEIC estimated that between 1769 and 1812, it invested almost £1 million in the silk production of Bengal.[80] The cost of setting up a filature with 208 furnaces was approximately £10,774.[81] All these costs were covered by the dewani and the EEIC did

[80] L/PARL/2/55: 'Appendix to the Fourth Report from the Select Committee on the Affairs of The East India Company, 1812', India Office Records and Private Papers, p. 217.

[81] IOR/E/4/625, 9 April 1779, pp. 131-32. The EEIC needed to incur these costs because if it wanted to capture a higher share of the British market it needed to make a "quality jump". By using the term

not have to draw funds from its trading activities to support the establishment of silk filatures. It is difficult to imagine that the EEIC would have invested this much into silk production in Bengal if it did not have access to "cheap money" in the form of dewani revenues. On the other hand, the Company was not motivated solely by the need to transmit revenues to Britain, it was also guided by mercantilist considerations. The aim was to make the most efficient use of the land and labour available in Bengal.[82]

The case presented here shows that the adoption of the factory-type system of production in the eighteenth-century Bengal silk industry was not detrimental to the EEIC's silk trade. According to data presented by William Milburn, in the period 1798-1803 the prime cost of silk production amounted to £1,425,466, sales profits were £1,967,985, with net profits of £542,519 (see Appendix B).[83] This evidence contrasts with findings for the cotton industry which show that the factory system did not emerge in the Indian cotton industry because the system could not cope with unfavourable

'quality jump' I am referring to a term used by Gerben Bakker in association with sunk costs. He argued that firms that want to break away from their competitors and capture a higher share of the market have to scale-up investment into improving the quality of their product. He illustrated this theory through the European and Hollywood film industries, Gerben Bakker, 'The Decline and Fall of the European Film Industry: Sunk Costs, Market Size, and Market Structure, 1890-1927', *Economic History Review* 58 (2), 2005, pp. 310-18.

[82] Considering the advantages of the adoption of the Piedmontese system, the main Superintendent of silk filatures in 1777 pointed to the fact that "these advantages have not been confined to the Increase of the Honourable Company´s investment only, but have procured a yet more considerable Benefit, by a Revenue arising from the lands that have been cleared  for forming new plantations of mulberry trees – these lands would never have been cleared, now cultivated has it not been for the introduction of the Italian method of spinning silk, whereby 7/9 of the men formerly employed the whole year in the Bengal method of spinning are now employed in the Bengal method of spinning, are now employed in the labours in agriculture". IOR/E/1/61 ff. 486-487v: 18 Nov 1777, 'Letter 240 James Wiss in London to the Court Outlining the Advantages of the Italian Method of Spinning Silk in Bengal', p. 487.

[83] William Milburn, *Oriental Commerce* (London: Black, Perry & Co., 1813), Vol. 2, p. 257.

factor endowments.[84] The evidence presented here shows that the situation was different for silk reeling and that the factor endowments did not play against a factory-type organisation.

The adoption of filatures in Bengal silk reeling had undeniable benefits. First, the quality of Bengal raw silk improved. Second, productivity increased. Quality improvement was the most significant benefit of the centralised system of organization. When the EEIC decided to adopt the Piedmontese system, the Court considered that the "real advantage arising from the Italian method, is the superiority of the quality of the silk".[85] This is not in line with the conclusions of Gregory Clark, that factory discipline was imposed on workers in order to facilitate intensive use of capital.[86] Nor was the Company primarily concerned with extracting more work hours per worker. Of course, the Company was concerned with the efficient use of capital and labour; however increases in the quality of raw silk were the main aim.[87] If the centralised system of organization was not implemented, the quality of Bengal raw silk would hardly have improved.[88] When the Piedmontese system emerged, the system enabled merchant-entrepreneurs to control both work effort and the quality of reeled silk.[89] Cheap labour and a favourable climate for cocoon cultivation created favourable conditions for silk reeling in Bengal. However, without the imposition of factory discipline, new reeling practices could not be imposed. The evidence shows that after the adoption of filature

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[84] Broadberry and Gupta, 'Lancashire, India', p. 300; Irfan Habib, 'The Technology and Economy of Mughal India', *Indian Economic and Social Review* 17 (1), 1980, pp. 32-34.

[85] IOR/E/1/61 ff. 486-487v: 18 Nov 1777, 'Letter 240', p. 487.

[86] Clark, 'Factory Discipline', pp. 129-33 and 160.

[87] IOR/E/4/625, 9 April 1777, p. 205.

[88] G/23/13: 'Factory Records: Kassimbazar, 1757-59', India Office Records and Private Papers, pp. 93-4, 96, and 108.

[89] Davini, 'History of Bengali Raw Silk', pp. 6-7 and 15.

production the quality of raw silk significantly improved.[90]

Second, the centralised system of production led to productivity improvements. The value of silk procured from Kasimbazar increased from 18,000 sicca rupees (£1,950) in 1768-72 to 36,000 sicca rupees (£3,900) in 1775-76 after the filature system was implemented. Such a large increase in the production of filature silk was not driven solely by increased production capacity in the filatures. The adoption of the mechanised Piedmontese method of reeling significantly increased labour productivity. One of James Wiss' letters pointed to the fact that "by the method of spinning silk with the Italian machines, two men make as much and better silk in a day than nine men would make of a bad quality by the old Bengal method".[91] The skills of reelers also played an important role and their productivity increased with training. James Wiss noticed that in the initial stages of training in the new method, reelers wasted a large number of cocoons. He specifically stated that: "a good workman will make 12 ounces of good silk with about 180 ounces of pods when a new beginner will make of the like quantity of pods of the same quality only 9 to 10 ounces of bad silk".[92] This evidence supports the argument that the Piedmontese system led to increases in labour productivity.

## 5.5. Conclusion

Differences in factor prices are currently used as the major determinants of technological paths. Factor-price theory can shed light on why some technology transfers fail. However, the theory is unable to capture all technology changes or explain technological paths. Some technological paths are guided by micro- rather than

[90] IOR/E/4/625, 27 May 1779 p. 343

[91] IOR/E/1/61 ff. 486-487v: 18 Nov 1777, p. 486.

[92] IOR/E/1/61 ff. 486-487v: 'Letter 240 James Wiss in London to the Court Outlining the Advantages of the Italian Method of Spinning Silk in Bengal', 18 Nov 1777, p. 487.

macro-inventions. The political economy, markets and institutions also play an important role.

Factor-price theory postulates that India was unable to switch to the factory system in the eighteenth century as the system did not fit India's factor-supply conditions. The case of the transfer of the Piedmontese silk reeling technology contradicts these predictions. The Piedmontese system of reeling – in spite of adopting a hierarchical organization of labour and advanced machinery – does not represent an example of capital intensive labour-saving technology. The cost of producing silk in filatures was lower than the cost of procuring it from intermediate merchants. The new technology entailed high initial costs, however analysis of the returns to investment shows that the investment was highly profitable. This can be explained by several factors specific to the Bengal silk industry. First, the Bengal silk industry, in contrast to the cotton industry, did not develop superior knowledge and expertise in raw silk production which would set it apart from its competitors but lagged behind technologically. Second, the efforts to increase the quality of Bengal raw silk necessitated both technical and organizational innovations.[93] Mere increases in labour intensity could not substitute technology and labour organization.

Overall, reeling silk in filatures had undeniable benefits. Without the adoption of a centralised system, the EEIC would not have been able to improve the quality of Bengal raw silk or increase productivity in silk production. The cost of producing silk in filatures was lower than the cost of procuring raw silk from intermediate merchants. Moreover, the plan to adopt the centralised system seems even more sensible when analysed from the point of view of value-chain and commodity-chain theory. It enabled

[93] Strict discipline, attention to detail and minute regulation were as important as the adoption of the Piedmontese reeling machine for the production of high-quality raw silk. Zanier, 'Pre-Modern European Silk Technology', p. 114.

the EEIC to take control over another stage of silk production, and this gave the Company the opportunity to control2 the manufacturing process and quality of production and to differentiate Bengal raw silk from other silk on the market.

# CHAPTER 6

## Institutional Failure of the 'Bengal Silk Enterprise'

> It has come to our knowledge that in its provision [of filature silk] of late years the grossest frauds and impositions have been practiced upon us both as to its quality and price.[1]

The importance of institutions in explaining the divergence between the West and the rest of the world was pointed out by Douglass North and Robert Paul Thomas several decades ago.[2] The role played by institutions in economic development was further studied by North as well as other scholars such as Daron Acemoglu, Simon Johnson and James A. Robinson, Kenneth L. Sokoloff, and Stanley L. Egerman.[3] In their accounts, institutions are closely linked to the divergence debate, considered from a macro-perspective and often connected to private property rights. Less research has been carried out about the impact of specific institutions in the success of production and trade ventures. Avner Greif has studied the role of private- and public-order punishment

[1] IOR/E/4/630, 21 July 1786, p. 537-38.

[2] Douglass C. North and Robert Paul Thomas, *The Rise of the Western World: A New Economic History* (Cambridge: Cambridge University Press, 1973).

[3] Douglass C. North, *Institutions, Institutional Change and Economic Performance* (Cambridge: Cambridge University Press, 1990); Daron Acemoglu, Simon Johnson and James A. Robinson, 'The Colonial Origins of Comparative Development: An Empirical Investigation', *American Economic Review* 91 (5), 2001, pp. 1369-1401; Daron Acemoglu, Simon Johnson, and James A. Robinson, 'Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution', *Quarterly Journal of Economics* 117 (4), 2002, pp. 1231-94; Kenneth L. Sokoloff and Stanley L. Engerman, 'History Lessons: Institutions, Factors Endowments, and Path of Development in the New World', *The Journal of Economic Perspectives* 14 (3), 2000, pp. 217-32.

mechanisms on the development of trade networks.[4] Other studies conducted have been concerned with problems of exchange or financial institutions.[5]

This chapter considers the effects of institutional frameworks on the EEIC's engagement with the Bengal silk industry. By drawing on the above-mentioned literature, I argue that the problem with the non-uniformity of the quality of the Bengal raw silk was essentially engendered in the institutional framework of the filature silk production in Bengal. The Company was unable to create institutions that would foster the production of high-quality raw silk under the filature system. Instead, the institutional framework created principal-agent problems and fraud. Hence, the EEIC's venture into Bengal silk production can be seen as an institutional failure. This chapter approaches institutions from the point of view of organisational theory. In line with Oliver Williamson, I argue for the significance of organizational structures suitable to achieve efficiency in production.[6] This chapter shows that it was not just the technological and labour demands that made the production of raw silk an intricate process in eighteenth-century Bengal; the institutional framework of production was equally if not more relevant.

[4] Avner Greif, 'The Fundamental Problem of Exchange: A Research Agenda in Historical Institutional Analysis', *European Review of Economic History*, 4 (3), 2000, pp. 251-84.

[5] Avner Greif, Paul Milgrom and Barry R. Weingast, 'Coordination, Commitment, and Enforcement: the The Case of the Merchant Guild', *Journal of Political Economy* 102 (4), 1994, pp. 745-76; Paul R. Milgrom, Douglass C. North, and Barry R. Weingast, 'The Role of Institutions in Revival of Trade: The Law Merchant Private Judges and Champaigne Fairs', *Economics and Politics* 2 (1), 1990, pp. 1-23; Douglass C. North and Barry R. Weingast, 'Constitutions and Commitment: The Evolution of Institutional Governing Public Choice in Seventeenth-Century England', *Journal of Economic History* 49 (4), 1989, pp. 803-32.

[6] Oliver E. Williamson, 'The Organization of Work: A Comparative Institutional Assessment', *Journal of Economic Behaviour & Organization* 1 (1), 1980, pp. 5-38; Id., 'Transaction-Cost Economics: The Governance of Contractual Relations', *Journal of Law and Economics* 22 (2), 1979, pp. 233-61; Id., 'The Theory of the Firm as Governance Structure: From Choice to Contract', *Journal of Economic Perspectives* 16 (3), 2002, pp. 171-95; Id., 'The Vertical Integration of Production: Market Failure Considerations', *American Economic Review* 61 (2), 1971, pp. 112-23.

## 6.1. Institutions and Bengal Filature Silk Production

The process of raw silk production was highly demanding from a technological as well as a labour point of view.[7] These two requirements made the production of high-quality raw silk possible only in China and in Italy.[8] Attempts to produce high-quality raw silk were made in several parts of the world in the eighteenth century.[9] For instance, attempts to implement the Piedmontese system of silk reeling were carried out in Midi France, in Portugal and in Hungary, though without achieving a long-term success.[10] In none of these cases the role of institutions was taken into consideration during the technology transfer. Attention was paid solely to the technological aspects of the Piedmontese method. Yet, implementing solely the Piedmontese reeling technology was simply not sufficient to make such projects successful. Several studies show that the organization of production was important in explaining the success of the Piedmontese silk production.[11]

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[7] Ben Marsh, *Georgia´s Frontier Women: Female Fortunes in a Southern Colony* (London: University of Georgia Press, 2007), pp. 53-59; Giovanni, Federico, *An Economic History of Silk Industry, 1830-1930* (Cambridge: Cambridge University Press, 1997), pp. 14-15. The analysis of the development of reeling technologies by Richard Hills well illustrates how technologically demanding the process was. Richard Hills, 'From Cocoon to Cloth: The Technology of Silk Production', in Simonetta Cavaciocchi (ed.), *La Seta in Europa Secc. XIII-XX* (Prato: Istituto Internazionale di Storia Economica, 1993), pp. 64-73.

[8] Claudio Zanier, 'Pre-Modern European Silk Technology and East Asia: Who Imported What?', in Debin Ma (ed.), *Textiles in the Pacific, 1500-1900. The Pacific World: Lands, Peoples and History of the Pacific, 1500-1900* (Aldershot: Variorum, 2005), pp. 109-111.

[9] Roberto Davini, 'A Global Supremacy: The Worldwide Hegemony of the Piedmontese Reeling Technologies, 1720s-1830s', in Anna Guagnini and Luca Molà (eds.), *History of Technology*, Vol. 32 (London: Bloomsbury Publishing, 2014), pp. 91-92.

[10] Roberto Davini, 'The History of Bengali Raw Silk as Interplay between the Company Bahadur, the Bengali Local Economy and Society, and the Universal Italian Model, c.1750 – c.1830', *Commodities of Empire Working Paper* 6 (2008), p. 5.

[11] Davini, 'History of Bengali Raw Silk', p. 15; Zanier, Pre-Modern European Silk Technology and East Asia', p. 131; Mauro Ambrosoli, 'The Market for Textile Industry in Eighteenth Century Piedmont: Quality Control and Economic Policy', *Rivista di Storia Economica* 16 (3), 2000, pp. 344-55.

In the case of Bengal, the EEIC neglected to consider the institutional framework of silk production. As a result, the organization of production was insufficient for the task of producing raw silk of Piedmontese quality, and it did not incentivise either reelers, overseers or filature supervisors to produce high-quality raw silk. The EEIC was able to make the Piedmontese method operational in Bengal and export filature silk to Britain. Yet, the quality of the Bengal raw silk remained below the quality of the Piedmontese product. Moreover, the raw silk exported to Britain was of unequal quality. The quality of silk differed among filatures, seasons, among bales of silk, and even within bales.[12]

In economics, the importance of the organization of production for achieving efficiency and for reducing transaction costs has been pointed out by Oliver Williamson.[13] The study of the organization of production and the organization of labour hold economizing on transaction costs as their central concept.[14] Every economic transaction has its cost: transaction costs define which mode of organization - market, hierarchy or some intermediate mode - will be the most economical.[15] Ronald Coase, and later Oliver Williamson, argued that when the costs of using price as the mechanism for organizing a transaction become too high, it is substituted by a different mode.[16] The most common solution for decreasing transaction costs is vertical integration: high

[12] IOR/E/4/626, July 1780, p. 191; IOR/E/1/66 ff. 422-424v: 'Letters 212-213 James Wiss in London to Peter Michell', 10 May 1780, p. 422; IOR/E/4/645A, 27 July 1796, p. 339; IOR/E/4/630, 12 April 1786, pp. 392-93; IOR/E/4/630, 21 July 1786, pp. 546-47.

[13] See, for instance: Williamson, 'Organization of Work', pp. 5-38; Id., 'Transaction-Cost Economics', pp. 234 and 245-46; Id., 'Theory of the Firm', p. 171-95.

[14] Williamson, 'Organization of Work', pp. 6 and 11-12; Id., 'Transaction-Cost Economics', pp. 234 and 245-46.

[15] Williamson, 'Transaction-Cost Economics', p. 234

[16] Ronald Coase 'The Nature of Firm', *Economica* 4 (16), 1937, pp. 3-5, Oliver E. Williamson, 'The Vertical Integration of Production: Market Failure Considerations', *American Economic Review* 61 (2), 1971, pp. 112-13; Id., 'Transaction Cost Economics', p. 234.

transaction costs create an incentive "to remove the transactions from the market and organize them internally".[17] If we apply this theory to the Bengal silk industry, the procurement of raw silk from peasants under the gomasta system entailed high transaction costs due to late deliveries, deliveries of silk of lower quality than what was contracted for and the fraudulent behaviour of both producers and gomastas.[18] These costs were significantly reduced as a result of the implementation of the Piedmontese system which introduced vertical integration in the reeling phase of silk production.

The implementation of the Piedmontese system only partly solved the agency problems by integrating production within the firm. However any firm needs governance and organization. Williamson describes the 'rules of the game' at a firm level as private ordering: "which entails efforts by the immediate parties to a transaction to align incentives and to craft governance structures that are better attuned to their exchange needs".[19] The two key domains of private ordering are incentive alignment and contract implementation.[20] In both of these domains the EEIC failed. The Company was unable to align the incentives of the Court in London with the incentives of Board of Trade in Bengal and the incentives of the Bengalese reelers. Moreover, the Company was unable to create a governance structure that would mitigate the agency problems that emerged with the implementation of the Piedmontese system.

The non-uniformity of the quality of the Bengal silk exported to London – silk of good quality was mixed with coarse silk which needed re-reeling – had its roots in the agency problems related to filature silk production. The transition to a filature system meant a vertical integration of production as the Company owned the fixed

[17] Williamson, 'Transaction Cost Economics', p. 234. Also Coase, 'Nature of Firm', pp. 4-7.

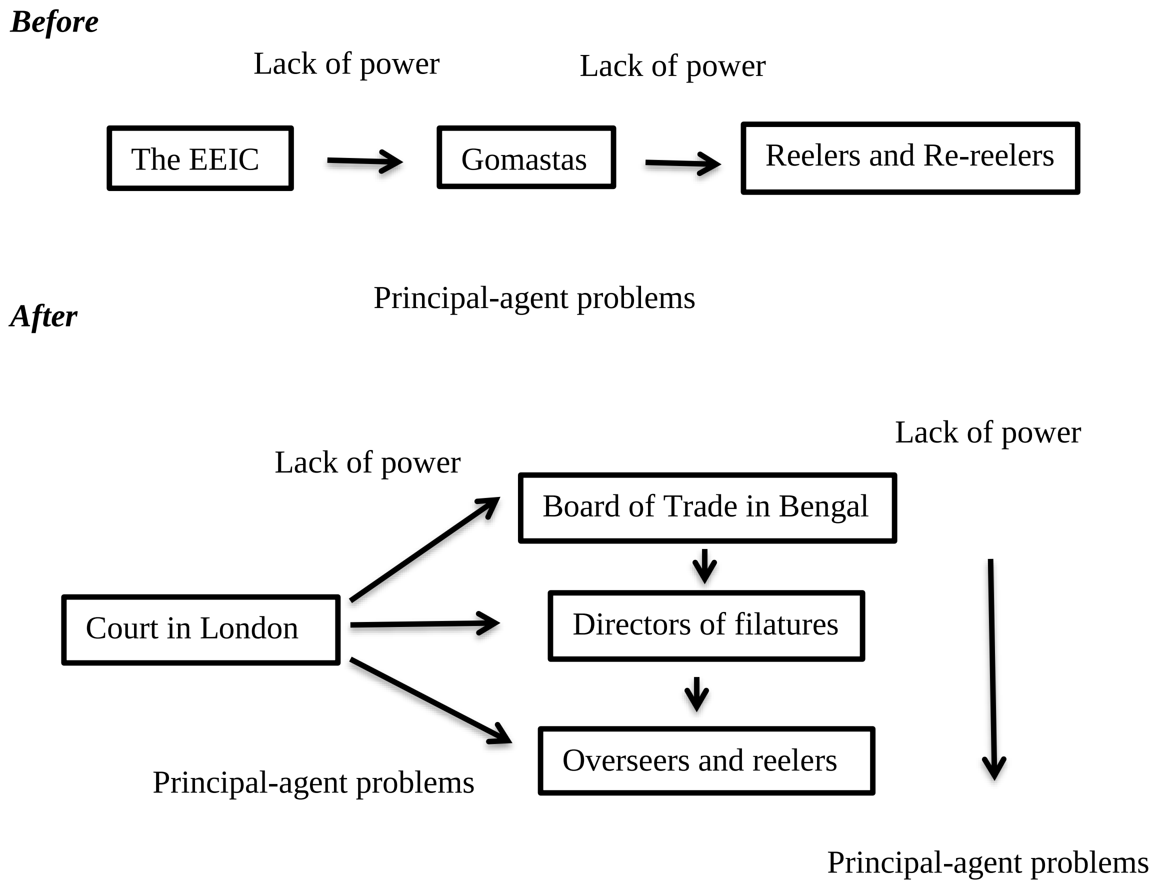
[18] IOR/G/23/13, 21 October, 1758, p. 114; IOR/G/23/13, 14 July, 1758, p. 70.

[19] Williamson, 'Theory of the Firm', p. 172.

[20] Ibid., p. 173.

capital of the filatures as well as the inputs necessary for production such as cocoons and wood for instance. The EEIC hired the former independent producers as employees in the filatures. Thus, the introduction of the Piedmontese system meant a reduction of the principal-agent problems existing between the Company and its gomastas on the one hand, and peasant producers on the other. The filature system, however, brought about a new set of principal-agent problems: between the Court in London and the Board in Bengal; between the Court and the directors of the filatures; and between the directors of the filatures and reelers (Figure 6.1).

**Figure 6.1. Agency Problems before and after the Implementation of the Piedmontese System**



The aim of the Court was to import filature silk of quality comparable to the Piedmontese product.[21] The Board of Trade in Bengal, directors of filatures and reelers faced incentives inconsistent with the production of high-quality raw silk. The Board of Trade had no positive incentive to favour quality.[22] Moreover, since the Court was unable to distinguish whether the low quality of Bengal filature silk was the result of a lack of attention by the Board to the issue of quality or to difficulties with implementing Italian technology in Bengal, dismissal stopped being an effective form of enforcement.[23] Reelers were paid piece-wages, which did not incentivise them to focus on quality as they were not rewarded for reeling high-quality silk.[24] The directors of filatures were in a position not dissimilar to that of the Board of Trade: they had no positive or negative incentives to favour quality.[25] Moreover, the directors of filatures

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[21] IOR/E/4/619, 31 January 1770, p. 655; IOR/E/4/628, 16 March 1784, pp. 260-61; IOR/E/4/628, 11 April 1785 p. 551; IOR/E/4/625, 9 April 1777, p. 171; IOR/E/4/648, 29 May, 1799, pp. 480-81.

[22] The Company records do not mention that the Board of Trade or the directors of the filatures were ever rewarded for supplying high-quality silk. See, for instance: IOR/E/4/625, 9 April 1779, pp. 133-34.

[23] In spite of the problems with the quality of the Bengal filature silk, the Court in London expressed its trust in the Board of Trade. IOR/E/4/637, 6 May 1791, p. 425; IOR/E/4/645A, 27 July 1796, p. 336.

[24] The Company's documents contain no evidence that would support the assumption that Bengalese reelers were paid time wages. Time wages were one of the innovations that characterized the Piedmontese system as practiced in the Kingdom of Savoy. The implementation of time wages was supposed to incentivize the reelers to favour quality over quantity. Davini, 'History of Bengali Raw Silk', p. 15. On many occasions the Court registered its displeasure with the practices of reelers. See for instance IOR/E/4/625, 9 April 1777, pp. 210-15. In most instances, complaints were associated to a lack of attention on the part of reelers to the appropriate procedures. It is clear that reelers favoured quantity. There is no indication that reelers were ever given rewards for reeling high-quality silk. This was later criticized by silk specialist Giuseppe Mutti. IOR, Bombay (Misc. Public Documents, etc.)., 1793.m.17: 'Letter from Giuseppe Mutti', p. 7.

[25] Although the Court ordered that any servant caught cheating on the quality of silk should be dismissed, the Court itself did not possess the means to uphold this order. IOR/E/4/620, 23 March 1770, pp. 54 and 63-64. The Company's documents do not contain any indication that the directors of filatures were rewarded for good service in silk production.

often lacked the necessary skills to detect shirking on the part of reelers, and were presented with no incentive to improve their knowledge in this respect.[26]

Such conclusions concerning the agency problems created by vertical integration are similar to the argument put forward by Rachel E. Kranton and Anand V. Swamy.[27] Kranton and Swamy have studied the problems faced by the EEIC with relation to the agency system in the procurement of textiles for export. They have suggested that vertical integration should have solved the agency problems. Their analysis has focused on opportunism and fraud, and not on meeting the standards of quality and the delivery deadlines by intermediary merchants and weavers.[28] They argue that, although vertical integration would have been a solution, centralization was difficult to achieve as the weavers were part-time agriculturalists dispersed over a large area. They also acknowledge that vertical integration would have brought agency problems since weavers and supervisors needed to be either incentivised or supervised.[29] This was an important issue for the Bengal filature silk production: without incentives or effectual supervision both Bengalese silk reelers and Company servants were prone to shirk on their duties.

[26] Due to a lack of knowledge of silk production, the directors of the filatures could easily be deceived. IOR/E/1/66 ff. 422-424v : 'Letters 212-213 James Wiss in London to Peter Michell', 10 May 1780, p. 422. The Company often expressed its 'wish' that the servants in Bengal would improve their knowledge of silk production, but never took any further step to ensure it. IOR/E/4/621, 7 April 1773, p. 471; IOR/E/4/623, 24 December 1776, p. 280-81. Moreover, fluctuation in the number of servants engaged in silk production and high turnover of servants responsible for enforcing quality in filature production did not help with enforcement of quality. IOR/E/4/625, 9 April 1779, p. 224.

[27] Rachel E. Kranton and Anand V. Swamy, 'Contracts, Hold-up, and Exports: Textiles and Opium in Colonial India', *American Economic Review* 98 (3), 2008, pp. 967-89.

[28] Ibid., pp. 979-80.

[29] Ibid., pp. 980-81.

From an organizational point of view, the essential innovation of the Piedmontese system was the introduction of hierarchy.[30] In Piedmont the transition from a putting-out system of silk reeling to a filature system strengthened the level of control of merchant-entrepreneurs over the production process.[31] By using Adam Smith's case of a pin factory, Stephen A. Marglin has shown how the organization of labour typical of a factory gives the entrepreneur a central role in production, which in turn enables him to control and stimulate the work effort of factory workers in order to produce a marketable product.[32] Marglin argues for the superiority of the factory system in the control it guarantees the entrepreneur over the production process. Control enables the entrepreneur to appropriate the benefits of innovation. Moreover, the discipline and supervision decrease production cost, and limit embezzlement.[33] Williamson's study argues that among all the possible modes of organization, the hierarchical mode is, all things equal, the most efficient institutional structure.[34] The

[30] The terms 'hierarchy' and 'factory' are sometimes used interchangeably in the literature on organization of work. See for instance: Williamson, 'Organization of Work', pp. 5-38.

[31] Merchant-entrepreneurs in Piedmont had control over the process even before the filature system was implemented. The new organization enabled them to increase their control. Davini, 'History of Bengali Raw Silk', p. 6.

[32] Stephen A. Marglin, 'What Do Bosses Do? The Origins and Functions of Hierarchy in Capitalist Production', *Review of Radical Political Economics* 6 (2), 1974, p. 62.

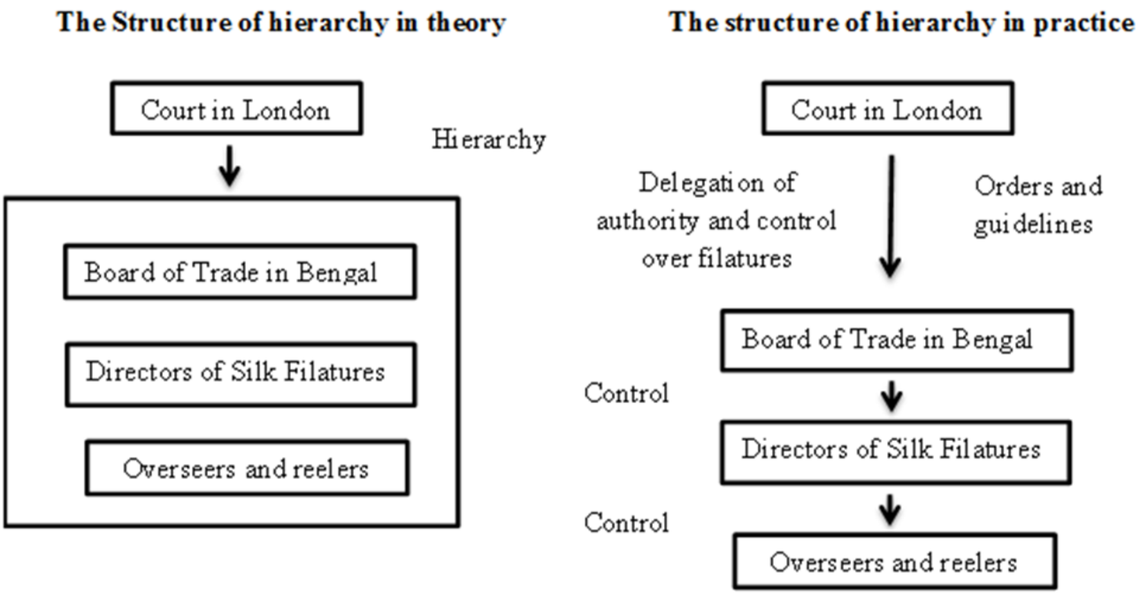
[33] Marglin, 'What Do Bosses Do?, pp. 82-84 and 90-96. Marglin's study has sparked a debate on the respective contributions of increased supervision and division of labour and of technological change. Marglin was criticised for being ideological and for misreading history. Landes in particular criticised Marglin for creating a perception of the entrepreneur as an individual who adds nothing to technical efficiency and receives disproportionate shares of profits. Landes also pointed to the benefits of specialization omitted by Marglin. David Landes, 'What Do Bosses Really Do?', *Journal of Economic History* 46 (3), 1986, pp. 585-623. In spite of such criticism, a number of economists and social scientists have since drawn on Marglin's work. See for instance: Williamson, 'Organization of Work', pp. 5-38.

[34] Although the employed technologies might make certain types of organization unfeasible, Williamson shows that the more hierarchical the mode of organization, the more efficient it is. Williamson, 'Organization of Work', pp. 12 and 28.

reason why hierarchy did not bring substantial benefits to the EEIC in Bengal is that the filature system did not guarantee the Court in London a control over the production.

The agency system in silk filatures had a clear hierarchical structure and relied on contractual relations with small-scale peasant producers only for the procurement of cocoons. However, agency problems were still abundant. In the case of Bengal, the merchant-entrepreneur was the Court in London. However, the Court did not have effectual control over the process of silk reeling (Figure 6.2). In contrast to the typical eighteenth-century merchant-entrepreneur, the Court owned several filatures but the geographical distance between the Court and the filatures was immense and the distance between individual filatures was equally vast. Hence, the Court had to delegate its authority and control. The Court in London did not have direct control over the silk production in Bengal but could only give directions to its Board of Trade in Bengal.

**Figure 6.2 Hierarchical Structure of the Filatures Silk Production in Bengal**




The Piedmontese reeling technology would not allow any other form of organization than a hierarchical one. Nor would other forms of organization enable the

EEIC to solve the problems of quality. The filature system was the only option available if the goal was to increase the quality of the Bengal silk. The Company's previous experience showed that it was impossible to implement changes to the reeling practices under a putting-out system. There are two reasons why the EEIC did not alter the institutional framework of silk production. First, the Court in London was confident that the implementation of the Piedmontese reeling system was an adequate solution for improving the quality of the Bengal silk. In the Company's correspondence, the Court expressed its surprise that the project was facing problems. Second, considering the time lag with which the Court obtained the silk and reports received about the condition of the Bengal filature production, it is no surprise that the Court remained unaware of the agency problems for several years. To sum up, the EEIC's venture into silk manufacturing failed because the Court was unaware of the role that the institutional framework had played in the success of Piedmont in silk production. Furthermore, many of the agency problems could have been avoided if the Company had not introduced contracting from private filatures.

## 6.2. Contracting and the Lack of Control over Production and Costs

The most acute instance of institutional failure was the introduction of a system of silk contracting from private filatures. I argue that the system had far-reaching consequences for the silk venture and that it well illustrates the inefficiency of the institutional framework of silk production. Contracting did not bring the EEIC any benefits. First, it inhibited competition among private filatures. Second, it expanded opportunities for fraud. Finally, it had a negative impact on the quality of the filature silk.

The Bengal silk industry was not the only case in which contracts with private individuals were used by the Company. Peter Marshall points to the fact that the EEIC relied on private initiative to supply new commodities such as sugar and indigo to European markets rather than becoming directly involved in their production.[35] He argues that it was a mutually profitable arrangement: “private European enterprise also profited by the Company’s policy of entering into contracts for building, shipping, or supplies in Bengal, rather than undertaking these services itself”.[36] I maintain that in the case of silk production, it needs to be assessed whether the EEIC profited from such an arrangement.

The system of contracting the EEIC implemented is known as ‘inside contracting’. The rationale of ‘inside contracting’ was to allow “a capitalist who has relatively little technical knowledge to employ his capital productively while limiting his involvement to negotiating contracts with inside contractors, inspecting and coordinating the flow of intermediate product, and taking responsibility for final sales”.[37] Unfortunately, none of the reasons for relying on inside contracting suited the Bengal silk production. First, the Court in London continued to accumulate knowledge about the ‘best practices’ that had to be implemented in order to improve the quality of silk; this knowledge was channelled to both the Company and private filatures.[38] Thus, inside contracting did not assist the Company to overcome any lack of knowledge. Second, the filature silk bought from private filatures was not inspected properly by the Company’s servants in Bengal and it was not discovered that the quality of the silk was often lower than what was expected by the Court in London. Thus, the Company did not

[35] Peter Marshall, ‘Private British Investment in Eighteenth Century Bengal’, in Patrick Tuck (ed.), *The East India Company, 1600-1858* (London: Routledge, 1998), Vol. 4, p. 130.

[36] *Ibid.*, p. 130.

[37] Williamson, ‘Organization of Work’, p. 17.

[38] IOR/E/4/646, 4 October, 1797, p. 829; IOR/E/4/626, 12 May 1780, pp. 100-105 and 207-9, LSE Archives, W7204, East India Company. *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India (London, J.L. Cox, 1836)*, p. xx.

gain any advantage by limiting its involvement in the production process – the knowledge accumulated by the Company about 'best practices' was often better than the technical knowledge in private filatures. The system did not solve the problem with the quality of silk. Whereas, the system guaranteed the private filatures sale of a determined quantity of silk for a set price, the EEIC had to take all the risk with selling the silk on the British market.

The introduction of the system of contracting for silk from private filatures meant the creation of an institution that aggravated the already existing institutional failure. Contracting expanded the scope for the opportunistic behaviour on the part of the Company's servants. Entering into contracts with private producers for the procurement of silk was a step backward as it introduced transaction costs similar to those the Company experienced when it procured reeled silk from local producers.

The Company was pushed into the contracting of silk from private filatures because of financial difficulties. Especially in the period of 1770s-90s the Company invested into securing and expanding its territorial gains, and funds were channelled into military pursuits.[39] Hence, the EEIC's initial comment that the dewani revenues were going to produce sufficient financial flows to cover the annual investment of export goods for the European markets proved to be overly optimistic. The Company needed to turn to other arrangements in order to be able to procure goods for Europe. In the case of silk production, it was decided that the easiest way to deal with a shortage of funds was to enable private individuals to build silk filatures in Bengal or to let them rent the Company's filatures to produce raw silk there. Most of the silk produced by private filatures was bought by the Company, although as observed by Marshall, private

[39] IOR/E/4/618, 24 December 1765, p. 97; IOR/E/4/638, 30 May 1792, p. 470; IOR/E/4/621, 7 April 1773, p. 506; IOR/E/4/623, 5 April 1776, pp. 269-76. IOR/E/4/628, 16 of March 1764, pp. 261-65. IOR/E/4/628, 11 April 1785, p. 555.

filatures also "no doubt sold part of their silk to 'country' traders, to the foreign companies, or to make up the 'privilege' of officers on East Indiamen".[40]

The procurement of silk from private filatures was based on contracts. The filatures entered into an agreement with the Board of Trade to deliver a determined quantity of silk at a set price, part of which was to be paid in advance.[41] The essential problem with contracting was that the authority to sign contracts was assumed by the Board of Trade. The Court in London had limited control over the Board and, as the evidence shows, the Board did not follow closely the directives received from London.[42] Disregarding the instructions from London, especially the directives concerning the length of the contracts, proved to be detrimental to the venture as it precluded competition among filatures.

The EEIC never stopped reeling silk in its own filatures and did not consider abandoning the production of filature silk altogether. The intention, as communicated from London to the Board of Trade in Bengal, was:

> as soon as ever you should perceive a prospect of being enabled to restore the accustomed quantity of Silk to our Investment without drawing Bills, lessening the quantity of Piece Goods, or other necessary applications of the Territorial Revenue you were then to give the necessary notice of two years to the Individuals engaged in that article and repossess yourselves of the Filatures and reassume the exercise of our exclusive right in this article.[43]

The Court ascribed importance to the production of silk but at the same time did not wish to jeopardize the trade of other export items.

[40] Marshall, 'Private British Investment', p. 136.

[41] Ibid., p. 136; IOR/E/4/626, 12 May 1780, pp. 205-22.

[42] IOR/E/4/626, 12 May 1780, pp. 215-22.

[43] IOR/E/4/628, 11 April 1785, p. 555.

The EEIC's financial situation did not sufficiently change for the Company to abandon silk contracting from private filatures until 1790s. Meanwhile, the Court in London expressed its disapproval of the contract system adopted by the Board. The principal complaint was the length of the contracts: the Court deemed that contracts were fixed for overly long periods of time and that this length prevented competition among contractors. The Court complained that: "the principle appears to us obviously wrong; and more especially so, respecting an Article of Investment, almost in the infancy of a new institution, which must therefore be deemed capable of great improvement [..] but the System of Contract for several years, at a regular price renders the former unnecessary, because a fixt rate is given for the whole period; and discourage, if not entirely precludes a sufficient competition in the provision".[44] As the Court argued, long-term contracts gave private filatures no incentives to reduce the production costs or to improve the quality of the silk.

The fact that the contracts were fixed for several years added to the already sub-optimal contracting systems as it removed incentives for the filatures to compete for contracts by decreasing prices. There are several hazards associated with inside contracting. First, is the hazard of incomplete contracting – it is nearly impossible to anticipate all possible contingencies of future development and make provisions for them in the contracts. Thus, contracts can often become disadvantageous, and that can happen especially with long-term contracts. Second, the negotiation and enforcement of contracts has high cost and any business needs to keep these costs as low as possible.[45] In the case of filature production, for instance, the enforcement of contracts under the

[44] IOR/E/4/626, 5 July 1780, pp. 215-17.

[45] Williamson, 'Organization of Work', p. 17 and 19; Id., *Markets and Hierarchies: Analysis and Antitrust Implications: A Study in the Economics of Internal Organization* (New York: Free Press, 1975), pp. 96-99.

existing institutional framework was impossible. Finally, inside contracting creates sub-optimal incentives: “contractors have an incentive to sub-optimise (shade quality) that is not operative among hourly employees”.[46] This last hazard had negative implications for silk production in Bengal. There were no incentives to improve the quality of silk. Especially, since the Company was unable to adopt an effective system of quality control. Such a system was a necessity if the system of contracting silk from private filatures was supposed to bring the Company the expected benefits.

## 6.3. Principal-agent Problems in Filature Silk Production

The magnitude of the principal-agent problems illustrates the extent of the failure of the institutional system of filature silk production. Silk production was not the only venture in which the EEIC faced the opportunistic behaviour of its agents. The essential difference is that in raw silk production the opportunism of the Company’s agents undermined the success of the venture itself. Agency problems were at the heart of the production of non-uniform quality filature silk. The agency system created incentives that prevented effectual quality control and created opportunities for fraud.[47]

[46] Williamson, ‘Organization of Work’, p. 27.

[47] Davini records the complaints made by several of the directors of filatures about the lack of control over reelers. The directors argued that it was not in their power to enforce improvement of the quality of filature silk because they could not control the reelers. Punishment or dismissal, they maintained, were not effective incentives. Two points, however, needs to be taken into consideration. First, complaints about the difficulty to impose discipline, limit turnover of workers etc. were very common in the first decades of factory system. Second, some of the directors of filatures cited by Davini – for instance Droz and Aldersey – were later convicted of committing fraud against the EEIC. Therefore, their testimonies need to be taken with caution. Moreover, as this chapter argues, the problem was the lack of supervision and attention to quality on the part of the directors of filatures and the Board of Trade rather than the inability of reelers to produce high-quality silk. Several filatures were producing high-quality silk throughout the period because they were properly managed, especially the filatures supervised directly by the Company’s silk specialists. For the complaints of the directors of filatures, see: Roberto Davini, ‘Una Conquista Incerta. La Compagnia Inglese delle Indie e la Seta del Bengala,1769-1833’ (Unpublished PhD

Principal-agent problem denotes the dilemma of how to motivate an agent to act in the best interest of the principal. It arises due to asymmetry of information or due to the interests of principal and agents being in conflict.[48] In the literature on the trading companies, principal-agent problems are usually associated with private trade. Private trade is said to cause misalignment of incentives. It has been argued that private trade was the major source of conflict between principals and overseas agents by K. N. Chaudhuri in the case of the East India Company, and by Kenneth G. Davies and by Charles Wilson for the Royal African Company.[49] Similar views were taken by Douglas MacKay for the Hudson Bay Company and by Thomas Stuart Willan for the Russian Company.[50] Although, this uniformly negative perception has recently been revisited by Santhi Hejeebu and Julia Adams, private trade is still seen as connected to malfeasance.[51] Interestingly, even the EEIC considered private trade as the major source of principal-agent problems and malfeasance. Therefore, private trade in raw silk was strictly forbidden.

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thesis, European University Institute, 2004), pp. 257-68; for discussion of early factory discipline see Sidney Pollard, *Genesis of Modern Management: A Study of the Industrial Revolution in Great Britain* (London: Edward Arnold, 1965), pp. 160-245. For examples of production of high-quality filature silk see: IOR/E/4/631, 27 March 1787, pp. 695-96.

[48] See Sanford J. Grossman and Oliver D. Hart, 'An Analysis of the Principal-Agent Problem', *Econometrica* 51 (1), 1983, pp. 7-46; Ray Rees, 'The Theory of Principal and Agent, Part I', *Bulletin of Economic Research* 37 (1), 1985, pp. 3-26.

[49] K. N. Chaudhuri, *The Trading World of Asia and the English East India Company, 1660-1760* (Cambridge: Cambridge University Press, 1978), pp. 208-13, 298-300 and 325; Kenneth G. Davies, *Royal African Company* (Chippenham: Longmans, Green & Co, 1957), pp. 163-65; Charles Wilson, *England´s Apprenticeship 1603-1763* (London: Longmans, Green & Co, 1971), pp. 174-76.

[50] Douglas MacKay, *The Honourable Company: A History of the Hudson´s Bay Company* (Toronto: McClelland & Stewart, 1949), pp. 66-67; Thomas Stuart Willan, *The Early History of the Russian Company, 1553-1603* (Manchester: Manchester University Press, 1956), pp. 258-67.

[51] Santhi Hejeebu, 'Contract Enforcement in the English East India Company', *Journal of Economic History*, 65 (2), 2005, pp. 498-500; Julia Adams, 'Colonialists and Company Men: The Decay of the Colonial Control in the Dutch East Indies', *American Sociological Review* 61 (1), 1996, pp. 12-26.

The EEIC was aware that private trade generated incentives for its servants that could potentially be in conflict with the Company's goals. The Court in London took into consideration the conflicting incentives associated with private trade when creating the institutional framework of filature production. In the attempt to create an environment favourable for filature production, the Company did not allow for country-wound silk to be procured from the silk aurungs in which filatures were set up.[52] This rule was implemented in order to avoid competition between cocoon and Putney procurement.[53] Still, the Court in London did not manage to align the incentives of its servants in Bengal with its own goals. The essential problem was the contracting for silk from private filatures. The contracts were signed by the Board of Trade that was in possession of information about the costs of filature silk production. However, this information was not made available to the Court in London.

I have already mentioned the extent to which the Company was dependent on its agents for implementing the intricate changes to the process of silk reeling. Apart from quality improvements, the Company also relied on its Bengal agents for producing filature silk in the most cost-efficient way. In the case of raw silk, the EEIC was not just procuring an item of trade but was directly involved in production. Therefore, opportunities for opportunistic behaviour on the part of the Company's servants increased.

[52] IOR/E/4/620, 23 March 1770, pp. 64-65.

[53] The Court in London considered that the implementation of this rule would guarantee that the best cocoons would be sold to the filatures instead of being reeled into country-wound silk. IOR/E/4/620, 23 March 1770, p. 63. The EEIC also attempted to regulate the establishment of native silk filatures and not allow them to be built in the vicinity of the Company's filature in order to limit the competition for cocoons. WBSA, BoT (Comm) Prcds 23 June 1778, Letter from Cossimbazar, dated 12 June 1778, as cited in Davini, Una Conquista Incerta, p. 174.

Asymmetry of information between the Board of Trade in Bengal and the Court in London became a major source of opportunistic behaviour in the production and procurement of filature silk. For example, during the period 1774-86 the Board of Trade was buying silk from private filatures for prices significantly higher than costs of production and its members were making profit at the expense of the EEIC (Table 6.1).

**Table 6.1. Contract Prices of Silk from Private Filatures, 1774-1784 (in Sicca Rupees/Seer)**

| Year | Country-wound silk (in Rupeess) | Filature silk | Costs of production of filature silk in EEIC's filatures |
|---|---|---|---|
| **1774** | 9 to 10 | 14 | |
| **1775** | 8.5 to 10.9 | 12.5 to 13.5 | |
| **1776** | 8.5 to 10.9 | - | |
| **1777** | 8.5 to 10.5 | 10.5 to 13.5 | |
| **1778** | 8 to 10.5 | 11.4 to 12 or 13 | 6 Rupees 3 Annas 5 Pice |
| **1779** | 8 | 11.6 to 12 | (or 6.2 Rupees) |
| **1780** | 8.4 to 11.1 | 11.6 to 12 | |
| **1781** | 8.8 to 11.1 | 11.6 to 12 | |
| **1782** | 7.8 | 8.8 | |
| **1783** | 7.8 | 8.8 | |
| **1784** | 7.8 | 8.8 | |

*Sources:* IOR/E/4/630, 12 April 1786, p. 389; TNA C 12/175/27, 24 March 1789 to 11 November 1789. The costs of production of filature silk in the Company's filatures, stated in the third column, were not cited for any specific year and should be considered as an average for the period.

All figures in the first two columns are in Rupees. Under the eighteenth-century monetary system in Bengal 16 Annas were equivalent to 1 Rupee and 12 Pice were equivalent to 1 Anna.

It took the Court in London several years to uncover this practice. The reasons why the Company was unable to detect this fraud sooner was the time-lag in communication and the lack of access to precise information.[54] In 1783 the Court demanded information about the breakdown of the costs of filature silk production but did not receive such

[54] Ann M. Carlos and Stephen Nicholas, 'Agency Problems in Early Chartered Companies: The Case of the Hudson´s Bay Company', *Journal of Economic History* 50 (4), 1990, p. 856; Hejeebu, 'Contract Enforcement', p. 497.

information from the Board.[55] A year later, in 1784 the Court turned to James Frushard – at the time the owner of a private silk filature in Bengal – for information about the breakdown of the costs of production.[56] The information the Court received confirmed that the price the Company was paying for filature silk was exorbitant. As table 6.1 shows, the prices for which the Company bought raw silk from private filatures (the EEIC bought both country-wound and filature silk) was considerably higher than the cost of reeling silk in the Company's filatures.

Once the Court uncovered the fraud, it sued the members of the Company's Bengal Board of Trade in Chancery in 1789. The case is well documented in the Chancery proceedings.[57] The suit was filed against eight former members of the Board of Trade in Bengal: William Aldersey, Philip Milner, Mr Dacres, Charles Bentley, Alexander Higginson, Simeon Droz, William Rook and William Harwood, as well as against several contractors. The contractors that were said to have derived most profit were Thomas Chapman, James Lucas Worship, James English Kegley, Joseph Barreto, James Burn, and John Fergusson.[58]

In its correspondence to Bengal, the Court described the fraud as "Contracts [that] were a collusive business between the Board of Trade and the Contractors, […] the former reserved to themselves a certain share of the profits, or had contained sums paid them for granting this Contracts at such high prices".[59] The Board of Trade had signed contracts for raw silk reeled in private filatures for a price significantly higher

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55 IOR/E/4/630, 21 July 1786, pp. 538-42.

56 IOR/E/4/630, 12 April 1786, p. 390; IOR/E/4/630, 21 July, 1786, pp. 538-42.

57 TNA C 12/175/27, 24 March 1789 to 11 November 1789; IOR/E/4/630, 12 April 1786, p. 392-93; IOR/E/4/630, 21 July, 1786, p. 537-42.

58 TNA C 12/175/27, 24 March 1789 to 11 November 1789. Several of the members of the Board of Trade were also the directors of the Company's filatures in Bengal, for instance Simeon Droz and William Alderrsey.

59 IOR/E/4/630, 12 April 1786, p. 391.

than the production cost. The profit that the private contractors made this way was then divided between the members of the Board and the contractors. The price for which the Board was procuring silk was on average 12 Sicca Rupees for a seer of yellow silk and 13 rupees for a seer of white silk.[60] However, according to the information the Court had obtained in 1786, the cost of producing one seer of silk in the Company's filatures was 6 Rupees 3 Annas and 5 Pice. On the local market in Bengal one seer of filature silk sold for 7 ½ Sicca Rupees.[61]

This case of fraud shows that the Company and its Court had no control over the Board of Trade and that the Court lacked the most basic information about filature production in Bengal. Moreover, the case also had a negative impact on the quality and consequently on the price of the filature silk on the British market. The EEIC was not making a loss on the silk from private filatures only because it was overcharged for the silk. Since the quality of the silk from private filatures was considerably lower than the silk from the Company's filatures, it also sold for lower prices. According to the Court's investigation 1 Rupee of silk produced in the filatures of the contractors that were part of the fraud did sell only about 1s. 1d per Rupee of silk.[62] Meanwhile the silk from the filatures of Mr. Speke and of Mr. Taylor, who did not participate in the fraud, was sold in London for 2s 6d and 2s 0.5d, respectively.[63]

What is striking in this case of the fraud is that the EEIC did not take any measures to prevent new cases of fraud in the future. The Court was well aware of the conflicting interests that the contracting of silk produced in the private filatures brought,

[60] IOR/E/4/630, 12 April 1786, p. 390.

[61] Ibid.

[62] Ibid., p. 392.

[63] Ibid.

as well as of the consequences for the quality of the silk. Commenting on the conduct of the Board of Trade, the Court wrote to Bengal:

> this is among the mischiefs arising from our Board of Trade (and perhaps our Silk Inspectors at Calcutta) being interested in the Contracts, this interest has led them either not to examine, or if they did examine, shamefully to pass every bad Silk when the best was contracted for.[64]

The problems with the quality of the silk produced in private filatures were similar to the problems associated with the system of procuring country-wound silk and re-reeling it. For instance, similarly to the gomastas in the pre-filature period, the contractors were supplying samples of silk of a quality higher than what they delivered in the end.[65] Still the Company made no attempt to change the institutional setting with the aim of overcoming these agency problems.

Although the Court in London regarded the information about fraud and agency problems as a "material for future reform", such reform was not supposed to change the institutions of silk production and procurement.[66] The Court remained convinced that problems with the quality of silk were solely due to a lack of knowledge and a lack of proper control of quality. It expected that the lawsuit in Chancery would act as a deterrent and argued that:

> without minute information of former bad practices you may not be able to apply a suitable remedy; and until our Servants are made sensible of our determination to furnish as well as to warrant feeling the effect of legal proceedings we fear

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[64] Ibid.

[65] Ibid.

[66] Ibid.

> will not be deterred from the pursuing of improper conduct in the modes hereby practiced or by some new invention.[67]

The Court perceived the problem as one caused by a lack of punishment and considered that the threat of legal punishment would be enough of an incentive for the servants to follow the orders from London. In this way, the Court completely disregarded the agency problems caused by asymmetries of information.

Contracting for silk was an institutional problem which negatively affected the whole venture in silk reeling. Peter Marshall argued that the collusive contracts between the Board of Trade and contractors of private filatures "had enabled individuals to invest much larger sums in expensive filatures than would have been possible if they had been forced to raise all their capital from their own resources. A more rigorous examination of silk prices paid by the Company is probably one of the reasons why private filatures disappeared in the early nineteenth century, and why Committees of the House of Commons were told in 1831 and 1832 that such filatures could no longer survive".[68] However, the sources do not contain any indication that the contractors used the finances gained due to the collusive contracts for improving the production of the filature silk. The case outlined here illustrates that the venture into silk reeling was institutionally and economically unstable.

## 6.4. A 'Market for Lemons' in Bengal Raw Silk

The production of substandard-silk was a further issue that had its roots in the institutional framework of production and had a negative impact on the profitability of the trade in Bengal raw silk. The trade in Bengal raw silk was hindered by the non-

[67] Ibid., pp. 392-3.

[68] Marshall, 'Private British Investment', p. 136.

uniformity of the quality of the silk and by asymmetries of information between the buyers and the producers. The fact that bales containing sub-standard as well good-quality silk were sold along bales containing silk of good-quality decreased the demand and the price of the Bengal raw silk. Lack of information on the part of the buyers significantly undermined efforts by the EEIC to establish a reputation of a high-quality for its filature silk. Whereas Piedmontese silk created a brand-name for itself, the inability of the Company to guarantee uniform standards of quality made the market for Bengal raw silk a 'market for lemons'.

George Akerlof's paper on 'market for lemons' presented a compelling argument about the economic costs of dishonesty under the condition of uncertainty about quality. The market for lemons model has been since applied to the market with used cars, health insurance, employment of minorities, later to the market for physicians and other qualified professionals, markets for hazardous products, etc.[69] This chapter argues that the eighteenth-century market in Bengal raw silk can also be considered a 'market for lemons'.

The market for lemons is a type of market failure caused by information asymmetry between buyers and sellers. As buyers cannot distinguish between the good and bad quality goods, both are sold at the same price, reflecting the average quality. This means that high-quality goods are sold at a price lower than their real value.[70] In extreme cases this market failure can drive a market out of existence as good-quality goods are no longer traded. Such a situation did not happen to the market in Bengal raw

[69] George Akerlof, '"The Market for Lemons": Quality Uncertainty and the Market Mechanism', *Quarterly Journal of Economics* 84 (3), 1970, pp. 488-500. These examples are studied by Hayne E. Leland, 'Quacks, Lemons, and Licensing: A Theory of Minimum Quality Standards', *Journal of Political Economy* 87 (6), 1979, pp. 1328-346.

[70] Akerlof, "Market for Lemons", pp. 488-9.

silk; however both the demand and the prices of raw silk were negatively affected by the creation of a 'market for lemons'.

The Company was aware that the price and demand for Bengal raw silk was dependent on its quality and that the improvement of the quality of the silk remained a priority.[71] The price that Bengal raw silk attained on the British market was contingent on its reputation, on the manufacturer's experience and on the availability of information about the quality of the raw silk. The EEIC was conscious of the fact that the buyers were 'suspicious' about the quality of the raw silk and wary of being deceived.[72]

The problem emerged due to an asymmetry of information between buyers and sellers concerning the quality of the goods for sale. As in the case of cars where buyers lack the information to assess which car is good and which one is 'a lemon', the buyers of Bengal raw silk did not have sufficient knowledge about the quality of silk in a particular bale.[73] Evidence shows that in 1780 it was found by the Company's London workers that "fine and perfect silk reels over or is put upon coarse and inferior silk which makes it expensive and difficult to work and skeins are three times too large also".[74]

The Company was aware of the continuing problems with the quality of Bengal silk as the instruction from London to Bengal repeatedly mentioned the necessity to enforce quality. Correspondence from London also contained reports detailing the adverse effects of a neglect of quality enforcement: "such a reception as is complained

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[71] L/PARL/2/55: Appendix to the Fourth Report of the Select Committee on the Affairs of the East India Company', p. 217.

[72] IOR/E/1/66 ff. 422-424v: 'Letters 212-213 James Wiss in London to Peter Michell, 10 May 1780', India Office Records and Private Papers, p. 422.

[73] Raw silk was commonly sold in bales.

[74] IOR/E/1/66 ff. 422-424v: 'Letters 212-213 James Wiss in London to Peter Michell', p. 422.

of may be productive of the worst consequences to the interest of the Company for if the appearance of the silk is so little to be expended upon from inspection, the buyers will grow so very suspicious that at the sales such silk as in reality might be worth 25 [s. per gr. lbs] will not be bid more than 20 for, if this only for fear of being deceived".[75] The silk specialists employed by the EEIC in London were well aware of the effects of uncertainty about quality on the buyers but could not do more than report the problem.

A decrease in the prices and a contraction of the demand for Bengal raw silk makes it clear that the problem with 'lemons' was a serious one. The Court sent several reports to Bengal stating that: "many other complaints of a similar kind have also been made; and also concerning the unevenness of threads in the same skain, and of foulness of the Silk, which is an evil that requires immediate correction".[76] The Court was anxious to remedy this problem because it was aware that it would affect the value and the sale price: "the first reeling, and outside coat of the Skain, is good Silk, but the middle, which forms a large part of the whole is found to be little better than Rubbish".[77] The Court was also well aware that the problem was caused by the faulty conduct of reelers and Bengal servants and not by any technical difficulty. James Wiss – the EEIC's inspector of warehouses in London – drew attention to the fact that the unevenness of the quality of the silk was badly affecting the Company's profits:

> such a trick, which is certainly done intentionally by his people [director of one of the filatures] who can plead no excuse either from the quality of the cocoons, nor from the reels, not from the spinners, for the first reeling and the outside coat of the skeins is good silk, but the middle, which is very considerable in quantity for the skeins are three times as large, (that is too heavy – being 9 ounces in

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[75] Ibid.

[76] IOR/E/4/626, 12 May 1780, pp. 111-12.

[77] Ibid., p. 113.

> weight) consists only of rubbish and of very coarse bad silk perhaps not worth 8 s. a pound, and thus a deception by which the Sircars may have got a few hundred pounds, will make Company liable to suffer an immense loss upon the whole sale.[78]

Wiss's conclusions were well informed as they were based on several years of experience in setting up silk filatures, training reelers and adapting the Piedmontese technology in Bengal.

Two aspects of the 'market for lemons' are particularly important in the case of the EEIC silks. First, the lemons market emerged because the Company was unable to control its servants and reelers in Bengal and therefore the quality of its product. Second, repeated interaction between seller and buyers did not solve the problem as game theory would suggest by decreasing the returns of dishonesty.[79] Both aspects illustrate the institutional failure that characterized the Company's Bengal silk enterprise, in particular the extent of the principal-agent problems. The Company was dependent on its servants to put into practice its plans and carry out the instructions from London. As for other agency relationships, the Company's directors in London

[78] IOR/E/1/66 ff. 422-424v: 10 May 1780: 'Letters 212-213 James Wiss in London to Peter Michell', pp. 422-23.

[79] In repeated trade relationships, reputation is supposed to solve commitment problem. One-off transactions suffer from high levels of commitment problem because all participants in the transaction gain from cheating. In repeated trade relations no-one gains from cheating because if one party cheats, it gains only from the immediate transaction but loses the possibility of becoming part of any further transactions. Greif, 'The Fundamental Problem of Exchange', pp. 261 and 276; Geoffrey Heal, 'Do Bad Products Drive Out Good', *Quarterly Journal of Economics* 90 (3), 1976, pp. 449-502.

and its managers and employees in India were susceptible to moral hazard due to the asymmetry of information and the conflict of interests between principals and agents.[80]

## 6.5. Conclusion

New institutional economics has brought attention to the essential role that institutions have in facilitating exchange and economic development. However, when it comes to early modern production ventures, the role of institutions is seldom taken into account. In this chapter, I relied on organizational theory to show that the institutional framework of filature production prevented quality improvements and led instead to fraud and the production of substandard silk.

The EEIC's venture in silk manufacturing in Bengal should be considered as an institutional failure. The Company was unaware of the role of institutional frameworks for the production of high-quality silk and solely focused on transferring reeling technologies. Meanwhile, the project was also being undermined by agency problems. Thanks to vertical integration, the Piedmontese system applied in Bengal mitigated the principal-agent problems associated with procurement of silk from producers under the gomasta system. However, new agency problems arose because the Company did not create a governance structure with incentives to focus on the quality and profitability of filature production.

Vertical integration is supposed to bring efficiency gains as the entrepreneur achieves control over production.[81] In the case of the Bengal silk production, geographical distance prevented the merchant-entrepreneur (the Court in London) to

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[80] The principal-agent problem was described by Stephen A. Ross,'Economic Theory of Agency: The Principal's Problem', *American Economic Review* 26 (2), 1973, pp. 134-39. The principal-agent problem in pre-modern trade was extensively studied by Avner Greif, 'Fundamental Problem of Exchange', pp. 251-84.

[81] Marglin, 'What Do Bosses Do?', pp. 61-63.

gain effectual control over the process of silk reeling and made the Court dependent on its servants in Bengal. The Court was oblivious to agency problems and instead of incentivising its agents to favour quality and implementing a system of quality enforcement, it allowed the introduction of contracting from private filatures. Contracting not only re-introduced transaction costs that vertical integration had eliminated, but also facilitated fraud and precluded quality improvements.

The fact that it took the Court ten years to find out that it was overcharged for the silk purchased from private filatures shows that the Court lacked the most basic information about filature production in Bengal. The asymmetry of information between the Board of Trade and the Court in London prevented the Court from becoming an agent of change in the Bengal filature production. Meanwhile, the Board of Trade had no incentive to focus on improving the quality of Bengal raw silk. In such circumstances, it should not be surprising that the Company could not guarantee the buyers that the Bengal silk would meet any quality standards. The inability to put in place a credible mechanism of quality control and enforcement led to the creation of a 'market for lemons' in Bengal raw silk. This translated into good-quality silk being sold under its value and to profit losses for the Company.

# CHAPTER 7

## 'The Bengal Silk Enterprise' and Adaptations

Adaptations are commonly seen key to the successful transfer of knowledge. Technologies need to be adapted to the local circumstances. Such arguments were presented by Liliane Hilaire-Pèrez, Nathan Rosenberg, and Edwin Mansfield among the many in relations to historic as well as contemporary technology transfers.[1] The literature on technology transfers argues that adaptations are decisive for making the transferred technology operational and its application in the new environment commercially successful. Such adaptations range from alterations to the machinery to alterations of the institutional framework of production and to facilitating backward and forward linkages, and the development of infrastructure.

As the previous chapter showed, institutional adaptations are important for the successful adoption of new technologies. This chapter considers the technical, commercial and economic, and social adaptations. In line with Edwin Mansfield, I argue for the significance of not only technical but also of the commercial and economic adaptations of transferred technologies in order to secure their economic success.[2] This chapter concludes that the English East India Company was successful in implementing technical adaptations of the reeling technologies. The EEIC also took positive steps

[1] Nathan Rosenberg, 'Economic Development and the Transfer of Technology: Some Historical Perspectives', *Technology and Culture* 11 (4), 1970, pp. 550-75; Liliane Hilaire-Pèrez and Catherine Verna, 'Dissemination of Technological Knowledge in the Middle Ages and the Early Modern Era: New Approaches and Methodological Issues', *Technology and Culture* 47 (3), 2006, pp. 535-59; Edwin Mansfield, 'International Technology Transfer: Forms, Resource Requirements, and Policies', *American Economic Review* 65 (2), 1975, pp. 372-76.

[2] Mansfield has pointed to the fact that in order for a technology to achieve economic success in a new environment, "it is very important that a proper mating occurs between the technological considerations, on the one hand, and the more purely economic considerations, on the other". Mansfield, 'International Technology Transfer', p. 373.

towards implementing economic and commercial adaptations. The implementation of such adaptations was however negatively affected by agency problems. Furthermore, the EEIC failed to develop backward linkages to sericulture. Developing backward linkages could be important as in the case of staple industries which rely on access to a suitable quality and quantity of inputs of raw materials to achieve a competitive advantage.

## 7.1. Adaptations and Technology Transfers

The literature shows that transfers of technologies from areas with widely differing factor endowments often fail. A handful of studies have emphasised that ready access to necessary inputs and to output markets are essential for any successful technology transfer.[3] These arguments draw on factor price theory. As valuable as these insights are, I have nonetheless shown in chapter 6 that differing factor endowments were not the reason why the transfer of the Piedmontese technologies to Bengal failed.[4] Moreover, as Shannon R. Brown observed, most studies pay only little or no attention to

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[3] There is a wealth of studies focusing on the transfer of technologies to the USA explaining the success or failure of these transfers by differences in factor endowments. Other studies look at the role of the changes in output markets. See for instance: David J. Jeremy, 'British Textile Technology and Transmission to the United States: The Philadelphia Region Experience, 1770-1820', *Business History Review* 47 (1), 1973, pp. 46-52; Peter Temin, 'A New Look at Hunter's Hypothesis about the Antebellum Iron Industry', *American Economic Review* 54 (3), 1964, pp. 345-51; D. C. Coleman, 'An Innovation and Its Diffusion: The "New Draperies" ', *Economic History Review* 22 (3), 1969, pp. 420-29; Yurio Hayami and Vernon W. Rutan, 'Factor Prices and Technical Change in Agricultural Development: The United States and Japan, 1880-1960', *Journal of Political Economy*, 78 (5), 1970, pp. 1135-136.

[4] Moreover, the study of transfer of dairy technology from Sweden to Uruguay shows that technology can adapt to the local factor endowment. After being adopted in Uruguay the technology became more labour intensive than it was in Sweden. Thomas Sterner and Ruben Tansini, 'Transfer and Adaptation of Technology: The Dairy Industry in Sweden and Uruguay', *Journal of Productivity Analysis* 5 (2), 1994, pp. 116-19.

other factors influencing the success of technological borrowing such as institutions, values, etc. in the importing country.[5]

The concept of adaptations came to the fore in debates about technology transfers in the 1970s, when it became clear that mere technical assistance to developing countries was not producing the results hoped for. The international diffusion of technology has been studied particularly by Nathan Rosenberg and Edwin Mansfield who argued that transferred technologies must often be adapted if they are to meet the needs of the recipient country.[6] Mansfield named differences in the size of the market, in the price of inputs, the cost, quality and capability of infrastructure, differences in taste and in climate as some of the key aspects that make adaptations necessary. Mansfield and his colleagues focused their research on transfers of technology especially at a firm level and they pointed to the fact that well-managed firms have better prospects to successfully implement technologies in a new environment.[7] Such

[5] Shannon R. Brown, 'Cakes and Oil: Technology Transfer and Chinese Soybean Processing, 1860-1895', *Comparative Studies in Society and History* 23 (3), 1981, pp. 449-50.

[6] Rosenberg mentions that technologies need to be adapted not only to economic but also to environmental conditions – to climate, geography and geology. Rosenberg, 'Economic Development', pp. 571-73. See also: Mansfield, 'International Technology Transfer', p. 373.

[7] Edwin Mansfield and Samuel Wagner, 'Organizational and Strategic Factors Associated with Probabilities of Success in Industrial R&D', *Journal of Business* 48 (2), 1975, p. 187. Edwin Mansfield was among the pioneers of the study of technology transfers and diffusions of innovations. David J. Teece, 'Technology and Technology Transfer: Mansfieldian Inspirations', *Journal of Technology Transfer* 30 (1/2), 2005, pp. 17-33. Writing with various co-authors, Mansfield focused on several aspects of technology transfers, especially on the firm level. See for instance: Edwin Mansfield and Anthony Romeo, 'Technology Transfer to Overseas Subsidiaries by U.S.-Based Firms', *Quarterly Journal of Economics* 95 (4), 1980, pp. 737-50; Edwin Mansfield, 'Intellectual Property Protection, Direct Investment, and Technology Transfer: Germany, Japan and the United States', *IFC Discussion Paper*, 27, 1995; Id., 'The Speed and Cost of Industrial Innovation in Japan and the United States: External vs. Internal Technology', *Management Science* 34 (10), 1988, pp. 1157-168.

firms, they argued, focus on commercial and economic aspects of technology transfer rather than solely on technological solutions.[8]

The case of the transfer of the Piedmontese technologies to Bengal supports the conclusion that a pure focus on technical aspects of transfers undermines the possibility of commercial success. Furthermore, this chapter underlines that institutional adaptations are as important as commercial, economic and technical adaptations because institutions are necessary for creating an environment conducive to technological adoption.

Technology can be defined as set of techniques and rules governing the production of goods and services.[9] Rosenberg has argued that “technological change is also (and perhaps even more importantly) a continuous stream of innumerable minor adjustments, modifications, and adaptations by skilled personnel, and the technical vitality of an economy employing a machine technology is critically affected by its capacity to make these adaptations”.[10] Similarly, Robert Evenson in his study of technological transfers in agriculture calls the introduction of new technology ‘adaptive invention’. His argument is based on the understanding that factor prices, soil and climate conditions or new agricultural inventions induce changes to adopted technologies.[11]

Although adaptations are crucial, they are the final phase of technology transfer and the most difficult to achieve. The most elementary phase of technology transfer is ‘material transfer’ – the export of new products or materials to a recipient country. Design transfer denotes the transfer of designs and blueprints and marks the

[8] Mansfield and Wagner, ‘Organizational and Strategic Factors’, p. 188.

[9] Robert Evenson, ‘International Diffusion of Agrarian Technology’, *Journal of Economic History* 34 (1), 1974, p. 51.

[10] Rosenberg, ‘Economic Development’, p. 569.

[11] Evenson, ‘International Diffusion’, p. 55.

phase of adoption of the new technology. At the end of this phase recipient countries have the ability to manufacture new products. The final phase is ‘capacity transfer’ – that is the building of the capacity to adapt new technologies to local circumstances.[12]

Rosenberg’s analysis of technological adaptations shows that changes can be radical because technologies are often transferred not only from one place to another but also from one industry to another.[13] However, even when a technology is transferred within one industry, changes inevitably are far-reaching.[14] In such a context, the difference between macro- and micro-inventions is useful for explaining the process of adaptation. We can consider the original transfer of technology as a macro-invention. The process of re-tooling and updating of the context in which the technology is utilised, can be seen as that of the realm of micro-invention. Joel Mokyr argues that “during the implementation stages, inventions were usually improved, debugged, and modified in ways that qualify the smaller changes themselves as inventions. The diffusion of innovations to other economies, too, often required adaptation to local conditions, and has in most cases implied further productivity gains as a result of learning by doing”.[15] Such micro-inventions are therefore decisive to the successful adoption of a technology.[16]

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[12] Mansfield, ‘International Technology Transfer’, p. 373.

[13] Rosenberg, ‘Economic Development’, pp. 552-54.

[14] This shows that even if a technology is not necessarily labelled as a ‘macro-invention’, it cannot be successfully adopted without large-scale alterations.

[15] Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress* (Oxford: Oxford University Press, 1990), p. 10.

[16] Joel Mokyr defines macro-inventions as “inventions in which a radical new idea, without clear precedent emerges more or less ab nihilo”. The distinction between macro- and micro-inventions was first made by Mokyr. He defined micro-inventions as “small, incremental steps that improve, adapt, and streamline existing techniques already in use, reducing energy and raw material requirements”. Such a definition of micro-inventions fits well the definition of changes that accompanied successful technology transfers. Mokyr argued that micro-inventions occur more frequently than macro-inventions and that they

The theoretical findings of Mokyr, Rosenberg and Mansfield about the role of adaptations have been reiterated in several case studies which show that adaptation were necessary especially when technologies spread to new regions, countries and continents. Rosenberg illustrated the key role of the institutional, managerial, technical and organizational adaptations in several industries after they spread from Britain to the US in the nineteenth century.[17] Lilliane Hilaire-Pèrez and Catherine Verna reached similar conclusions for early modern technology transfers as did Michael Pearson in his studies of adaptations of European technologies to the environmental and social conditions of Australia.[18] Warwick Pearson, relying on his study of transfer of the watermill technology from Britain to Australia in the nineteenth century has drawn several conclusions about the extent of necessary adaptations of imported technologies. He found that the extent of adaptations depended on differences between the economic and environmental contexts. Moreover, technologies and the materials necessary for the construction of the 'hardware' of the technologies – that is machinery and equipment – were often transformed under the influence of adaptive pressures from the existing

account for most of the gains in productivity. Moreover, macro-inventions are not feasible without micro-inventions. Although Mokyr did not dispute the vital contribution of the key 'macro-inventions' of the industrial revolution such as Arkwright's water-frame or steam engine, he decisively shifted the attention to micro-inventions. What he emphasized was the fact that it took time for these macro-inventions to find wide usage and that adaptations were often indispensable. Mokyr, *The Lever of Riches*, p. 13.

[17] Rosenberg, 'Economic Development', pp. 552-73.

[18] Hilaire-Perèz and Verna, 'Dissemination of Technological Knowledge', pp. 535-59. Pearson's research focused particularly on the whaling and lime industries. Michael Pearson, 'The Technology of Whaling in Australian Waters in the Nineteenth Century', *Australian Journal of Historical Archaeology* 1 (1), 1983, pp. 40-54; Michael Pearson, 'The Lime Industry in Australia – An Overview', *Australian Journal of Historical Archaeology* 8 (1), 1990, pp. 28-35.

system of manufacturing. Socio-cultural variables also played an important role in creating an environment either facilitating or opposing transfers.[19]

Although the majority of studies on technology transfers emphasise the importance of economic factors, several of them nonetheless claim that transfers of technologies often necessitate adaptation to the social environment. Janet Hunter, for instance, illustrates how the required attributes of employees and social perception of gender influenced the gender division of labour in postal and telephone communication services in Meiji Japan.[20] Another factor that should not be overlooked is the local political-economy context as resistance to transferred technologies can impair efforts to adapt them. Brown has demonstrated that the adoption of the Western technology of soybean crushing to China in the nineteenth century failed not because of the incompatibility of the technology with the Chinese factor endowments or environmental conditions, but because of the opposition of merchant guilds and government officials.[21]

Similarly, the evidence for the silk industry shows that in the case of successful transfers, a series of micro-inventions which altered the technology to make it suitable to the new environment followed.[22] Most of the research on technology

[19] Warwick Pearson argues that in the colonial context "sociocultural values of tradition will quickly give way to those of innovation, and even long-established traditional technologies will not survive transfer". Warwick Pearson, 'Water Power in a Dry Continent: The Transfer of Watermill Technology from Britain to Australia in the Nineteenth Century', *Australian Historical Archaeology* 14 (1), 1996, pp. 58-59.

[20] The gender division of labour in Japan was not very dissimilar to Western industrial economies. Yet, adaptations were necessary if the new technologies were to comply with Japanese social norms. Janet Hunter, 'Technology Transfer and the Gendering of Communications Work: Meiji Japan in Comparative Historical Perspective', *Social Science Japan Journal* 14 (1), 2011, pp. 1, 5 and 9-18.

[21] Brown, 'Cakes and Oil', pp. 454-61 and 463.

[22] For silk industry, see: Debin Ma, 'Why Japan, Not China, Was the First to Develop in East Asia: Lessons from Sericulture, 1850-1937', *Economic Development and Cultural Change* 52 (2), 2004, pp. 369-94; Yukihiko Kiyokawa, 'Transplantation of the European Factory System and Adaptations in Japan: The Experience of the Tomioka Model Filature, *Hiotsubashi Journal of Economics* 28 (1), 1987, pp. 27-39.

transfers in the silk industry has focused on transfers of silk twisting technologies.[23] Comparatively less research is concerned with silk reeling technologies.[24] From the point of view of adaptations, the most interesting case was the transfer of reeling technologies to Japan. Comparing this case with the transfer of the Piedmonese reeling technologies to Bengal can shed light on some of the shortcomings that technological adaptation encountered in the Subcontinent.

Successful transfers of reeling technology were carried out in Japan in the nineteenth century and a century later in East Asian countries.[25] In both cases, adaptations of foreign technology were key to their successful adoption. The first phase of the transfer of European technologies of raw silk production to Japan was not dissimilar to that of Bengal. In the late nineteenth century the Meiji government decided to implement a European system of filature reeling.[26] Similarly to the case of Bengal, the process was managed by foreign silk specialists and machinery was imported from Europe. The first Japanese filature, the Tomioka filature, followed the European system of filature production in its entirety. However, as it soon turned out, the filature suffered

[23] See for instance: José M. Lopes Cordeiro, 'A Technology Transfer in Portugal's Late Eighteenth Century: The Royal Silk Twisting Mill of Chacim', *Textile History* 23 (2), 1992, pp. 177-88; Walter Endrei, 'The Italian Contribution to the Development of Sericulture in Hungary', in Simonetta Cavaciocchi (ed.), *La Seta in Europa Secc. XIII-XX* (Prato: Istituto Internazionale di Storia Economica, 1993), pp. 301-13; Giuseppe Chicco, *La Seta in Piemonte 1650-1800: Un Sistema Industriale d'Ancien Regime* (Milano: Franco Angeli, 1995), pp. 247-94.

[24] Transfer of Piedmontese technologies is briefly mentioned by Chicco, *La Seta in Piemonte*, pp. 288-94.

[25] Kiyokawa, 'Transplantation of the European Factory System', pp. 27-39; Kazuko Furuta, 'Silk-Reeling in Modern East Asia: Internationalization and Ramifications of Local Adaptations: In the late Nineteenth Century', in Debin Ma (ed.), *Textiles in the Pacific, 1500-1900. The Pacific World: Lands, Peoples and History of the Pacific, 1500-1900* (Aldershot: Variorum, 2005), pp. 191-221.

[26] Kiyokawa, 'Transplantation of the European Factory System', p. 27.

losses.[27] This initial failure was followed by the implementation of a series of adaptations to suit the local conditions. The filature switched from a 'quality-first' (that is a focus on the production of small quantities of very high-quality thread) to 'quantity-first principle' (with a focus on the production of large quantities of medium-quality thread). Production thus concentrated on thicker silk. Alterations of labour management (such as the introduction of gang-production system) were implemented and a system of quality control was also introduced.[28]

The technical principles according to which new filatures were built were altered as well. In the decade following the setting up of the Tomioka filature, the new filatures that were erected were smaller than their predecessor and did not use steam-power. They also had smaller production capacity, used less advanced machinery and were more labour intensive.[29] These adaptations of the filature system were supported by institutional and social adaptations and by the development of sericulture.[30] Debin Ma observed how the expansion of the production of raw silk was supported by the development of social and physical infrastructure – such as legal system, public education, research, modern monetary and banking systems, new transportation and communication systems – during the Meiji period.[31] The new infrastructure helped the

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[27] It has been argued by Kiyokawa that the modern factory system and social conditions in the filature were too "idealistic for the pre-industrial society of Japan". Kiyokawa, 'Transplantation of the European Factory System', pp. 27-28 and 30.

[28] Ibid., pp. 31-34.

[29] Steam was substituted for water, Ibid., p. 34.

[30] For instance, the government and entrepreneurs made efforts to remove prejudice against Western culture as part of their efforts to promote Western technology and create a favourable environment for the development of silk reeling. Kiyokawa, 'Transplantation of the European Factory System', p. 34; Ma, 'Why Japan, Not China', p. 375-76.

[31] Ma, 'Why Japan, Not China', pp. 374-6 and 383. The efforts to develop social and physical infrastructure falls in the category of 'capacity building'. Capacity building has been mentioned by the opponents of pure laissez-faire approaches to technology development in developing countries as

transportation of cocoons to filatures and silk thread for export and created the human capital necessary for research and innovations in sericulture. Domestic innovations in sericulture played an important role in the expansion of silk production in nineteenth-century Japan.[32]

In the rest of this chapter I will point to the several differences that emerge when we compare the Japanese experience with Bengal a century earlier. First, in Bengal technical adaptations were given comparatively more attention than economic and commercial adaptations. Second, it took the EEIC several years before it favoured a 'quantity-first principle'. Third, since the adaptations in Bengal were designed by silk specialists they narrowly focused on technical and commercial problems and did not pay enough attention to the institutional framework of silk reeling. And finally in the case of Bengal the development of sericulture was not sufficiently promoted.

## 7.2. Adaptations in Sericulture

Silk reeling is an activity with excellent potential for creating backward linkages. Backward linkages denotes the situation in which growth in one industry creates opportunities for the growth of industries/agricultural activities etc. that are supplying inputs to it and this has positive externalities for the former industry. Alas the EEIC was unable to implement adaptations to the Bengal sericulture, it failed to stimulate backward linkages to sericulture. Linkages theory has been put forward by Albert Hirschman in the field of industrial development. Hirschman argued that industries

essential for successful technology borrowing. See, for instance: Sanjaya Lall, 'Technology Capabilities and Industrialization', *World Development* 20 (2), 1992, p. 181.

[32] Ma, 'Why Japan, Not China', pp. 374-76 and 383.

differ in their capability to create backward, forward, and demand linkages.[33] He considered the linkages effects as investment-generating forces which "are set in motion through input-output relations" of different productive activities.[34] The focus of this theory is on the potential of industries to spark industrial development. However, we can also approach linkages from the point of view of the benefits that they create for the development of a transplanted industry. It is undoubtedly beneficial for an infant industry to have access to domestic inputs. For certain industries, as for example staple industries, backward linkages can be a source of competitive advantage. For instance, in the case of silk reeling access to good-quality cocoons was key to determining the quality and cost of the final thread. From this perspective, the EEIC suffered a considerable disadvantage due to the lack of adaptation of sericultural practices.

A significant difference between the Japanese and Bengalese case of transfer of reeling technologies was a lack of changes in Bengalese sericulture. When adapting the Piedmontese system of reeling to the Bengal environment, the EEIC paid special attention to the technical adaptations of the reeling technology and to commercial adaptations. In contrast, the EEIC's attempts to adapt sericulture never got beyond the stage of experimentation. Such neglect had inevitably a negative impact on the quality of the silk produced in the Bengal filatures.

Claudio Zanier has noted how the seventeenth- and eighteenth-century Piedmontese superiority in the production of raw silk was underpinned not only by technical innovations but also by important institutional changes in production. Such changes – he notes – "also reverberated back to the agricultural phase in compelling

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33 Albert Hirschman, *The Strategy of Economic Development* (New Haven, London: Yale University Press, 1958); Albert Hirschman, 'A Generalized Linkage Approach to Development with Special Reference to Staples', in Albert Hirschman, *Essay in Trespassing, Economics to Politics and Beyond* (Cambridge: Cambridge University Press, 1981), pp. 59-97.

34 Hirschman, 'Generalized Linkage Approach', p. 65.

producers to raise cocoon quality".[35] The case of nineteenth-century Japan also point to the importance of adapting sericultural practices. Debin Ma has argued that the development and technological upgrading of sericulture aided the success of Japan in becoming a major exporter of raw silk.[36] The EEIC, on the other hand, made no serious attempt to alter sericulture in Bengal. It must be said that the silk specialists sent to Bengal by the Company pointed to the fact that sericultural practices were no less problematic than those of silk reeling. By neglecting to address these issues and by focusing solely on silk reeling, the Company undermined its attempts to improve the quality of Bengal raw silk. As one of the silk specialists contended, attaining perfect cocoons was central to improving the quality of raw silk since "notwithstanding the ability of workmen perfect silk cannot be reeled from bad cocoons".[37]

According to the Company's silk specialists, several defective practices employed in Indian sericulture negatively affected the quality of the cocoons. Among such practices were the training of mulberry as a shrub; opposition against feeding the worms with mulberry tree leaves; economizing on mulberry leaves consumption; keeping worms crowded on mats and the method of killing the moth inside a cocoon; as well as the improper handling of silkworms and eggs facilitating their 'degeneration'.[38] The training of the mulberry as a shrub instead of a tree – which was the general practice in India – was based on the assumption that mulberry trees cannot otherwise

[35] Claudio Zanier, 'Pre-Modern European Silk Technology and East Asia: Who Imported What?', in Ma (ed.), *Textiles in the Pacific,* p. 139.

[36] Ma, 'Why Japan, Not China', p. 370.

[37] IOR, Bombay (Misc. Public Documents, etc.)., 1793.m.17: 'Letter from Giuseppe Mutti to John Bell Esquire on 20th October 1838', India Office Records and Private Papers.

[38] IOR, Bombay (Misc. Public Documents, etc.)., 1793.m.17: 'Letter from Giuseppe Mutti', pp. 5-7; Mr. Atkinson was resident at Jungypore, his analysis of sericulture from 1779 is in full cited in J. Geoghegan, *Some Account of Silk in India, Especially of the Various Attempts to Encourage and Extend Sericulture in that Country* (Calcutta: Department of Revenue and Agriculture, 1872), p. 7.

survive the climatic conditions of Bengal. This assumption was proven to be false by experiments made in the eighteenth century.[39] It was strongly criticized in particular by the Company's silk specialist Giuseppe Mutti.[40] He named the cultivation of a mulberry as a shrub among the most serious obstacles to getting better-quality cocoons. A mulberry shrub does not give as much leaves as a tree, and leaves of a shrub are less suitable for silkworms. Moreover, the training of a mulberry as a bush is more labour intensive and necessitates higher land input. Although the bush system allowed to purchase silk five or six times a year in comparison with just three or four times for tree system, the silk obtained was lower in quality and quantity.[41]

The opposition to feeding the worms with mulberry tree leaves was due to it being thought to produce coarser silk.[42] Economising on the leaves consumption or keeping worms too crowded, would not allow them to be properly fed thus having detrimental effects to their health. The outcome was that the worms needed longer time to spin and the cocoons that they produced were of lower quality.[43] Giuseppe Mutti also argued that worms that are crowded produce less silk. He assumed that if the worms were kept in better conditions only some 10,000 worms would be needed to produce as much silk as 15,000 worms when crowded on the mats. Yet, in spite of these observations, the Company did not attempt to alter the practices of sericulture.

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[39] These experiments were carried out by Giuseppe Mutti who proved that mulberry trees can be cultivated in Deccan.

[40] The practice of cultivating mulberries as shrubs was also criticized by James Frushard – the superintendent of silk investment in 1780s. IOR, Bombay (Misc. Public Documents, etc.)., 1793.m.17: 'Letter from Giuseppe Mutti, p. 5; WBSA, BoT (Comm) Prcds 13 January1789. Observations of the Superintendent of Silk Investment, as cited in Roberto Davini, 'Una Conquista Incerta. La Compagnia Inglese delle Indie e la Seta del Bengala,1769-1833' (Unpublished PhD thesis: European University Institute, 2004), p. 67.

[41] IOR, Bombay (Misc. Public Documents, etc.)., 1793.m.17: 'Letter from Giuseppe Mutti, pp. 5-7.

[42] Geoghegan, *Some Account of Silk in India*, p. 3.

[43] IOR, Bombay (Misc. Public Documents, etc.)., 1793.m.17: 'Letter from Giuseppe Mutti', pp. 6-7.

The EEIC was well aware that the quality of cocoons had an important effect on the quality of reeled thread: “Mr. Wiss had succeeded to admiration in drawing a tolerable silk from the most ungrateful cocoons, that the sickliest worms under the most unfavourable season” gave.[44] The Company, however, was convinced that the most decisive factor for the quality of cocoons was the quality of the silkworm breed. Therefore, the Court was concerned with attempts to introduce foreign breeds of silkworms rather than with facilitating an overall change in sericulture.

For several reasons, however, the Company’s efforts towards introducing new silkworm breeds to Bengal never progressed beyond the stage of experimentation. The EEIC was most interested in introducing the silkworm breed reared in Italy. However, the attempts were hindered by the geographical distance and problems with keeping at least some of the worms alive during the passage to India.[45] Considering the long duration of the journey, supply of leaves for feeding the silkworms became the principal obstacle.[46] In 1836 the EEIC summed up these efforts by stating that: “It must be obvious, that the introduction of the Italian worms into India could not have been effected without great difficulty, on account of the length of the voyage, and the danger of the worms perishing from being deprived of food during the passage”.[47] Neither were attempts to introduce silkworms from China successful. For the same reasons as with

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[44] LSE Archives, W7204, East India Company, *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London, J.L. Cox, 1836), pp. xiii, xiv

[45] The Company sent silkworm’s eggs from Europe, however, the eggs hatched during the passage to India.

[46] In this respect the EEIC cites the problems encountered in the attempt to bring sericulture to St. Helena. Most of the silkworms died during the journey due to lack of nourishment. LSE Archives, W7204, East India Company, *Reports and Documents*, p. xv.

[47] Ibid., p. xiv.

the Italian silkworms, the EEIC was also unable to secure a sufficient quantity of silkworms to make a decisive impact on cocoon production in Bengal.[48]

A further issue was the so-called "degeneration" of the imported silkworms.[49] Degeneration was a term used for describing the process in which the succeeding generations of imported silkworms lost their ability to produce silk of a quality superior to the Bengal breed. This was the case of the silkworms imported from China in 1771: it was argued that the worms degenerated due to "carelessness and improper management".[50] The degeneration of silkworms was a serious obstacle for improving the quality of cocoons.[51] The Court registered such concern also in 1790s when it decided against the introduction of the apparently superior breed of silkworms from the Coromandel Coast.[52] Similarly, contemporary publications by the EEIC considering Bengal raw silk production often mention degeneration as a problem.[53]

Considering the fact that degeneration was a recurring topic, it might seem surprising that the EEIC never attempted to address the issue. However, addressing the causes of the degeneration of the silkworms would mean dealing with the defective practices employed in sericulture and such practices could not be changed under a putting-out system. The cause of the degeneration of silkworms was said to be the improper rearing of silkworms: in particular, the practices of feeding the silkworms not enough mulberry leaves, feeding them leaves of inappropriate quality and keeping the

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[48] Geoghegan, *Some Account of Silk in India,* pp. 5-7.

[49] The expression "degeneration" is widely used in the EEIC's correspondence and documents, it was also used by the foreign silk specialists.

[50] According to Atkinson as quoted in Geoghegan, *Some Account of Silk in India,* p.7. The main causes were said to be "improper food" and "improper management" of silkworms. WBSA BoT (Comm) Prcds 21 April 1789, Letter from Jungypore, 21 April 1789 as cited in Davini, 'Una Conquista Incerta', p. 96.

[51] WBSA, BoT (Comm) Prcds 3 May 1796, Letter from Jungypore dated 25 April 1796, as cited in Davini, 'Una Conquista Incerta', p. 95.

[52] The project was never realized. IOR/E/4/640, 25 June 1793, p. 518.

[53] Interestingly the term "degeneration" is still used in the literature on sericulture.

silkworms in an unhealthy environment.[54] Thus, the same practices that were said to be the cause of the production of low-quality cocoons, were also behind the 'degeneration' of silkworms. The key problem was that the reason for employing such methods was not a lack of knowledge of the best practices, but the opportunistic behaviour of peasants. It was argued that the peasant:

> may pay attention to a portion of his cocoons, for the purpose of delivering the same as a sample for fixing the factory prices for a silk harvest, yet no sooner are their prices established and published and it becomes his immediate interest to distribute the mulberry plants he can command to as many silkworms as the same can possibly keep alive.[55]

The problem was very similar to the one the Company faced when procuring re-reeled silk from gomastas in 1750s. The system of fixing prices for cocoons according to the samples from the beginning of the rearing season motivated peasants to focus on cocoons' quality only when rearing silkworms for sample cocoons. After the price was fixed, the peasants stopped focusing on the production of high-quality cocoons and aimed instead at producing the highest quantity of cocoons possible. Thus, the quality of the cocoons delivered to the Company at the end of the rearing season was significantly lower than that of the sample cocoons. If the peasants focused on the production of high-quality cocoons, these were mostly intended for local trade. This was detrimental to the Company's business, especially since the rearing of the whole crop of silkworms was financed from the Company's advances.[56] Peasants reportedly reeled some of the

[54] These reasons were argued by Mr. Atkinson, a resident at Jungypor filature, to be at the heart of degeneration of silkworms. As cited in Geoghegan, *Some Account of Silk in India*, p. 7.

[55] Atkinson as cited in Geoghegan, *Some Account of Silk in India*, p. 7.

[56] Ibid.

cocoons that they produced to sell raw silk on the local market.[57] However, this needs to be assessed in the context of pre-modern production under a putting-out system, in which embezzlement of part of the advanced material was largely tolerated and anticipated.[58]

The fact that the peasants could sell part of their produce on the local market was not the only impediment to getting high-quality cocoons. The more serious obstacle was the system of procurement of cocoons. When procuring cocoons from peasants, the EEIC relied on intermediaries called Pykars. Pykars bought cocoons from the country-side to the Company's filatures.[59] Relying on Pykars solved the problem of how to procure cocoons from peasants scattered round the large expanse of the Bengal country.[60] Such dependence, on the other hand, created new problems: in the 1780s the Company found that the Pykars "sometimes use the most unjust oppression in forcing from the Chassars [peasants rearing silkworms] the Cocoons at their own prices. The Pykars after putting a profit and we have no doubt a handsome one upon them sell them to those engaged in the Silk Filatures by whom they are manufactured into Silk".[61] The reliance on Pykars was also problematic because the Company was being overcharged

[57] Ibid.

[58] Douglas W. Allen, *The Institutional Revolution: Measurement and the Economic Emergence of the Modern World* (London: University of Chicago Press, 2012), pp. 196-99.

[59] IOR/E/4/630, 21 July, 1786, p. 548.

[60] Goldsmiths' Library [G.L.], 1775 fol.: George Williamson, *Proposals Humbly Submitted to the Consideration of Court of Directors for Affair of the United Company of Merchants of England Trading to the East Indies: For Improving and Increasing the Manufacture of Silk in Bengal* (London, s.n., 1775), p. 15

[61] IOR/E/4/630, 21 July, 1786, p. 548. Roberto Davini mentions that Chassars preferred to reel cocoons into country-wound silk and then sell it on local markets because they could get a better price for their silk this way. Davini, 'Una Conquista Incerta', p. 47. I argue that the low prices offered by Pykars and their behaviour towards Chassars needs to be considered as the main reason why Chassars preferred to sell their production on the local market.

for cocoons.[62] Moreover, and more importantly, Pykars made use of price mechanisms to stimulate production of high-quality cocoons impossible. If the price of cocoons were set by the Pykars, the EEIC could hardly reward the production of high-quality cocoons through higher purchasing prices.[63]

Under the putting-out system and under the system of procurement of cocoons the EEIC was unable to implement changes to the practices of silkworm rearing. The problem was acknowledged also by the Company's servants. Mr Atkinson and George Williamson, for instance, acknowledged the fact that the Company needed to get directly involved in sericulture if the quality of cocoons was to improve.[64] Mr Atkinson commented on both the quality of the silkworm breed in India and the issue of 'degeneration' and linked them to the system of cocoon procurement. Atkinson argued for the introduction of foreign breeds. However he also warned against degeneration of the foreign silkworms if they were to be distributed among peasants "as indeed is evident in the case of the China cocoons".[65] The method he championed was the "establishment of breeding houses or nurseries under the inspection of silk agents for the purpose of rearing cocoons for supplying the filature".[66]

[62] The Company suspected that there was a "secret understanding between the Pycars, the Banians [merchants] and the Contractors [of private filatures]" which was driving up the prices of cocoons. WBSA, CCC Prcds 25 July 1771, Letter from Cossimbuzar, 8 July 1771, as cited in Davini, 'Una Conquista Incerta', p. 131.

[63] In all likelihood, Pykars must have created an incentive for the peasants to focus on production for the local market .The discontent of peasants with the oppressive practices of Pykars was registered even before the filature system of raw silk production was put in place and it was considered by the Company to be a serious threat to its investment policy. IOR/E/4/620, 23 March 1770, pp. 61-63.

[64] See Atkinson as cited in Geoghegan, *Some Account of Silk in India*, p. 7; Goldsmiths´ Library [G.L.], 1775 fol.: Williamson, *Proposals*, p. 17.

[65] Atkinson as cited in Geoghegan, *Some Account of Silk in India*, p. 7.

[66] Ibid.

George Williamson, a former servant of the EEIC in Bengal, proposed that the grounds around filatures be appropriated for the cultivation of mulberry trees with huts to rear silkworms to be set up on the grounds as well.[67] That would have allowed the EEIC to control sericulture and to oversee every stage of production of the silk thread. Williamson further proposed the Company to employ whole families in the production of silk thread: men in mulberry cultivation, women in the rearing of silkworms and children in silk reeling.[68] Although such an approach would undeniably have given the EEIC greater control over cocoon production, Williamson's plan was difficult to implement. This is because, notwithstanding the political control of Bengal, the EEIC was never able to monopolize Bengal's rural production and trade. There are numerous examples in the literature showing the Company's inability to change the trade patterns or to alter production in India in order to suit the Company's export needs.[69]

Altering the system of sericulture would be exceedingly difficult.[70] Rearing silkworms remained a household activity at least until the late nineteenth century in all

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[67] [G.L.], 1775 fol.: Williamson, *Proposals*, pp. 17-18.

[68] Ibid., p. 18.

[69] Giorgio Riello, *Cotton: The Fabric that Made the Modern World* (Cambridge: Cambridge University Press, 2013), pp. 62-64; Bishnupriya Gupta, 'Competition and Control in the Market for Textiles: Indian Silk Weavers and the English East India Company in the Eighteenth Century', in Giorgio Riello and Tirthankar Roy (eds.), *How India Clothed the World: The World of South Asian Textiles, 1500-1850* (Leiden: Brill, 2009), pp. 292-97.

[70] LSE Archives, W7204, East India Company, *Reports and Documents,* p. xxxiv. "That mulberry plantations can be established on account of the Company, so as in time to render the public investment in a considerable degree independent of the other sources of supply of cocoons, is not, we conceive, to be expected, considering that, for the accomplishment of such an ends, lands to so great an extent must be cultivated, and servants so numerous must be employed, as well as buildings be erected for rearing of cocoons comprehending altogether such a field of care and superintendence, as no Resident [director of filature] could be competent to, in addition to the minute and constant attention requisite to the peculiar and important duty of manufacturing silk. Such a plan, even if it were found to be practicable, should, in all probability, from the greatness of the expense attending it, prove decidedly objectionable." LSE Archives, W7204, East India Company. *Reports and Documents,* p. 63.

silk producing regions of the world. Coercing whole families to become involved in sericulture under the EEIC's management and control would require more political power than the Company had. Moreover, direct supervision of the rearing activities would be very expensive. Giovanni Federico has argued that the principal reasons for sericulture to remain a household activity were its labour intensity and the high costs of supervision that centralization of sericultural production would elicit.[71]

The fact that the Court never attempted to control sericulture should be seen as part of the general policy of the Company in procurement of goods for export: the Court emphasised that under all circumstances preference should be given to contracting for finished products rather than the Company becoming involved in production.[72] Silk reeling was an exception to this rule. The Court believed that amending the reeling practices was a sufficient measure to attain Italian-quality raw silk. Moreover, the Court was convinced that considerable improvement to the quality of reeled silk would be achieved if cocoons were handled in an appropriate manner.[73]

The Court showed concern over the way cocoons were being stored. Inappropriate modes of storing cocoons were known to have a negative impact on the

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[71] In many regions sericulture remained a household activity even in the twentieth century and entrepreneurs gained control over the production process by creating dependence. For instance, in Japan raw silk manufacturers gained control "by providing scientifically bred silkworm eggs and detailed technical guidance" as well as by signing long-term direct purchase contracts with the farmers. Ma, 'Why Japan, not China', p. 381. Giovanni, Federico, *An Economic History of Silk Industry, 1830-1930* (Cambridge: Cambridge University Press, 1997), p. 16. In Japan the problems with quality of cocoons were overcome under the household system of production thanks to institutional innovations. A new system of contracts called "sub-contractual long direct purchase system" emerged and institutionalised a long-term system of purchase contracts between farmers and filatures. Ma, 'Why Japan, Not China', p. 379.

[72] IOR/E/4/630, 12 April 1786, p. 272.

[73] The guidelines produced by James Wiss and summing up the best practices that were to be implemented in filature silk production contain a long passage with detailed description of how the cocoons should be handled. IOR/E/4/625, 9 April 1777, pp. 173-85.

quantity of silk reeled from cocoons, on the colour of the silk, and consequently on the Company's profits:

> Supposing a quantity of Cocoons, this taken care of produce 1000 lb. of good Silk; the same quantity, and of the same kind, not carefully placed, not frequently turned, will probably not produce 950 lb., perhaps not near so much, of inferior Silk, indifferent in quality, and defective in colour; for Cocoons neglected will grow mouldy, and from this will originate all the evils above specified respecting Silk spun from damaged Cocoons. It will not be in the power of the Spinners to prevent Silk made from such Cocoons from being discoloured; the Contractors will get nothing by it; and the Company will loose the profit, which they would otherwise gain, upon Silk made from good Cocoons.[74]

In order to prevent these problems the Court ordered that all "bad" cocoons were to be separated from the good ones upon arrival at the filatures. The Court sent to Bengal a very detailed explanation of the necessity to rigorously implement such a step: "every Cocoon that is bruised, or in which the Worm has been squashed, will spoil as many good Cocoons as come in contact with it; and all such Cocoons will grow mouldy, foul the water in the Pan exceedingly; and infallibly cause the Silk to be of bad Colour".[75]

Apart from sending instructions about the best practices of handling cocoons, the Court ordered the Board of Trade to promote mulberry cultivation in Bengal. The Court was very keen on extending the area of mulberry cultivation as it reckoned such a step indispensable if the quantity of silk exported from Bengal to Europe was to increase. In 1769 the Court ordered that the rents on land planted with mulberries were to be diminished so as to make mulberry cultivation more profitable for the landowners

[74] Ibid., pp. 182-84.

[75]Ibid., pp. 172-74.

and peasants. The Court also encouraged the Board to find other measures which would promote mulberry cultivation.[76] The Court repeated its order to the Board to find new policies to promote the cultivation on several other occasions as for instance in 1776, when it also suggested that waste lands should be cleansed and turned into mulberry plantations.[77]

Overall, the lack of improvement of the quality of the cocoons represented an impediment to the improvement of the quality of the silk thread. Due to the lack of control over peasants – peasants could sell their cocoons on the local markets – the EEIC could impose no practical measures of quality improvement. Rearing silkworms under the Company's direct control would have been very expensive. Nevertheless, in the end the most serious problem was the way in which cocoons were handled by the EEIC's servants. Roberto Davini has argued that the quality of cocoons was the single most important impediment to quality improvement of Bengal raw silk. Yet, even if the EEIC was able to effect the quality improvement of cocoons, without appropriate handling and storage their quality would have notwithstanding quickly deteriorated.

[76] IOR/E/4/618, 16 March 1768, p. 919, IOR/E/4/619, 17 March 1769, p. 334. The Court also attempted to improve the practices of mulberry cultivation. The Company's silk specialists sent guidelines about the best practices of mulberry cultivation and they also attempted to introduce Chinese varieties of mulberry tree. However, their effort did not have a decisive impact because it was difficult to enforce new practices and the introduction of Chinese mulberry tree did not spread beyond experiments. WBSA, BoT (Comm) Prcds 29 May, 1789, Letter from Maldah 7 April 1789 as cited in Davini, 'Una Conquista Incerta', p. 68; WBSA, BoT (Comm) Prcds 29th May 1789, Letter from Ragnagore 21 March 1789, as cited in Davini, 'Una Conquista Incerta', p. 69. WBSA, BoT (Comm) Prcds 29 of May 1789, Letter from Commercolly 14 February 1789, as cited in Ibid., p. 69.

[77] IOR/E/4/623, 24 December 1776, pp. 284-86. The Court was also keen to promote mulberry cultivation on waste lands. In this regard the plan was influenced by mercantilist thinking. IOR/E/1/61 ff. 486-487v : 'Letter 240 James Wiss in London to the Court Outlining the Advantages of the Indian Method of Spinning Silk in Bengal, 18 November 1777', p. 447.

## 7.3. Adaptations of the Reeling Technology

The Company focused in its efforts to improve the quality of the Bengal raw silk exclusively on the phase of reeling and paid attention also to the adaptations of the transferred technology. Claudio Zanier has observed that “without organisational, professional, and technical improvements, mere innovation would not work”.[78] The EEIC focused above all on technical adaptations. Such technical innovations implemented in Bengal were crucial for making the Piedmontese technology operational in the new context. This chapter illustrates that the technical adaptations were thorough and efficient in addressing the technical issues, however their implementation was not without problems.

The Company directed its attention to adapting the reeling machinery to the Bengal environment. Considering that little attention was paid to adaptations of the institutional structure and to adaptations of sericulture, it is important to note that the Company spared no effort to solve the technical problems with reeling machinery. Two points need to be made in this respect: first, the Company only implemented innovations necessary to make the reeling machinery operational in the Bengal climate. The overall productive capacity or any other aspect of the technology were not altered. Second, the EEIC depended on the knowledge and advice of James Wiss, one of the silk specialists in the Company’s services, for designing the adaptions of the machinery.

James Wiss planned most of the adaptations of the reeling machinery.[79] Wiss’s guidance was also essential for the correct assembling of the reeling machines. He set precise guidelines about the distances between the different parts of the reeling

[78] Zanier, ‘Pre-Modern European Silk Technology’, p. 133.

[79] IOR/E/1/63 ff. 158-160v : ‘Letter 70 and James Wiss in London to the Court Making Proposals Relating to Alterations in the Filature of Raw Silk at Calcutta’, 28 October 1778; IOR/E/4/625, 14 July 1779, pp. 484-86.

machine.[80] Such detailed instructions were indispensable for making the machine operational as well as for producing raw silk of appropriate dimensions. For instance, keeping the appropriate distances between the staves of the reel was of primary importance as otherwise the resulting skein of silk would not answer the requirements of the European market.[81] Wiss also advised the Court to send more silk specialists to Bengal and on several occasions suggested suitable candidates.[82]

The climate of Bengal necessitated two types of adaptations: adaptations of the machinery and of its maintenance.[83] Most pressing were the problems with the wheels used in the reeling machines. In Piedmont, cog wheels were made of wood, however the weather in Bengal was detrimental to the use of wood. Wiss pointed out the problems arising from the use of wooden cog wheels and instigated the change of wooden cog wheels for brass ones.[84] The Court in London observed that: "one capital defect attending filature Silk has arisen from the bad condition of the Cog Wheels, which by the heat of the Sun and damp of the night frequently become cracked and damaged".[85] Thus, it was decided that the wooden wheels would be substituted with brass ones and later that the axis of reels be made of hardened steel. The Court had the cog wheels and

[80] IOR/E/1/66 ff. 422-424v : 'Letters 212-213 James Wiss in London to Peter Michell Complaining about the Quality of some of the Bengal Silk and Enclosing Drafted Instructions to be Inserted in Instructions to the Weavers', 10 May 1780, p. 424; IOR/E/4/638, 30 May 1792, p. 624.

[81] The skein was to be 40 inches in length and 80 inches in circumference, IOR/E/1/66 ff. 422-424v, p. 424.

[82] IOR/E/1/63 ff. 19-20v: 'Letter 8 Report of James Wiss to the Committee of Correspondence on the silk trade in India', 14 July 1778, p. 21; IOR/E/1/65 ff. 440-441v : 'Letter 270 James Wiss in London to the Court Recommending the Appointment of 3 Superintendents for the Raw Silk Filature in Bengal', 20 Dec 1779, p. 441.

[83] Buildings also had to be adapted to the weather conditions. Resilient materials such as bricks and wood had to be used in the building of the filatures. Moreover, filatures had to be closed rather than semi-open because of the rainy weather. However, this created the problem of how to dispose of the fumes created by the furnaces. Davini, 'Una Conquista Incerta', pp. 230-32.

[84] IOR/E/4/625, 14 July 1779, pp. 484-86.

[85] Ibid., p. 484.

reels made in Britain and sent to Bengal. The number of the wheels and other components sent in 1780s was sufficient to equip all the filatures. The Court also ordered the cog wheels to be sent to private filatures, though, it expected to be reimbursed.[86]

Change to the material of cog wheels required changes in the whole construction of the reeling and double crossing machines. Although such changes were small, they still caused confusion among the Company's servants and reelers. The Court had to repeatedly send guidelines on how the brass cog wheels were to be used and how the reeling machine was to be altered. To avoid problems, models showing how the wheels were to be put onto frames to construct the reeling machine were sent from London.[87] The models were to be copied in Calcutta so that every filature could receive two models.[88]

The climate had a negative impact on the lifespan of the equipment used in the filatures and it became necessary to implement specific rules for the maintenance of the machinery. This applied also to the brass cog wheels and to the new reels partly made of steel. The Court was well aware of the importance of maintenance and the orders sent to Bengal were very precise in this respect:

> In regard to the quality of this Brass Cog Wheels we are persuaded if they are kept properly oiled and cleaned (neither of which we fear has been the case) they would last many years. The Steel Axis should be oiled every day or as often as wanted and the Wheels should be covered from dust and cleaned as often as experience might shew they require.[89]

[86] Ibid., p. 486.

[87] IOR/E/4/625, 14 July 1779, p. 485; IOR/E/4/626, 12 May 1780, p. 107.

[88] IOR/E/4/625, 14 July 1779, p. 486.

[89] IOR/E/4/628, 11 April 1785, pp. 560-61.

The Company had to wrestle not only with the effects of the weather on the machinery but also with the resistance of its servants and reelers to these adaptations. The Court, for instance, had to persuade the servants in Bengal about the usefulness of the new materials. In 1782, the Court wrote to the Board of Trade in Bengal:

> We were convinced of the efficacy of those Implements before we sent them out, and we are surprised at the doubts and difficulties that started to impede their effect, for we did not send the Brass Cog wheels to perform different variations, from the wooden ones, as both are acting perfectly the same after the Piedmontese principle, which is the only one we can permit to be made use of, let the Instrument be constructed of wood, Brass or Iron.[90]

Although the models sent to Bengal to show the setting of the machinery helped to overcome such resistance, adaptations were not implemented as smoothly as the Court expected.

All of this shows that the Company spared no effort to make alterations to the machinery that would remedy the technical problems and make it more suitable to the conditions of Bengal. The Court in London even evaluated the impact of the innovations as can be understood from a letter to the Board of Trade in Bengal: "we also direct that a few of the Reels that are worn out may be carefully packed and sent home to us by some of the returning Ships, noting how long they were in use, in order that by an inspection of their defects, it may be discovered whether any and what means may be adopted to remedy the same".[91] The Court was very keen to receive feedback. Apart from evaluating the used machinery, it also demanded that "after sufficient trial", the Board would send a report on the merits of the innovations.[92] The feedback that the

[90] IOR/E/4/627, 12 July 1782, p. 350.

[91] IOR/E/4/628, 11 April 1785, p. 561.

[92] IOR/E/4/629, 8 July 1785, p. 90.

Court received shaped further efforts and practical problems in putting the altered machinery into use:

> The wheels are thicker, the axis much stronger and the bearings are 3 or 4 times as broad besides which one of them is made of hardened Brass and the other hard cast Iron and they have holes through them to admit clean oil.[93]

Moreover, plentiful attention was being paid to making the altered machinery easy to maintain:

> These Reels are not to be screwed down horizontally upon the wood frame but must be fixed vertically with the wood pegs uppermost which pegs must be taken out to put oil in them and then put in their places again to keep out dust and dirt.[94]

Thanks to the silk specialists, the Company had very precise knowledge of the practical problems with maintenance of the machinery. Overall, the Company was successful in adapting the reeling machinery to the Bengal environment.

## 7.4. Commercial, Economic and Social Adaptations in the Bengal Raw Silk Production

Commercial and economic adaptations are part of the final phase of technology transfers. They are integral to building the capacity to adapt production processes in order to manufacture products that answer the specific demand of the markets. [95] For instance, in the Japanese case, one of such adaptations was the switch to the production of coarser silk. When studying the transfer of the Piedmontese technologies to Bengal, it

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[93] Ibid.

[94] Ibid.

[95] Mansfield, 'International Technology Transfer', p. 373.

is useful to focus on commercial and economic adaptations because these were essential not only to make the technology useful in Bengal but also to produce raw silk satisfying the demand in London.

It cannot certainly be said that the transfer failed due to a lack of attention to the adaptations of Bengal raw silk to the needs of the British market. The Court had up-to-date knowledge about the demand in Britain and the EEIC embraced several commercial adaptations. The first adaptation the EEIC adopted was quality differentiation. In the 1780s the EEIC started to differentiate the thickness of the Bengal filature silk into sorts A, B, and C.[96] The Company became aware that the principle of distinguishing quality according to the number of cocoons that were used in the production of the thread was inadequate. The Court complained about the old system: "We deem this a very indefinite Mode of Expression, as the Cocoons of Italy may differ from those of India or China so much that a given Number of each may for a Thread of a very different Size".[97] The Court was very attentive to the issue of creating standards of fineness of silk. In 1796 it started distinguishing sort A into No 1, 2 and 3, with No 1 being the finest. It was even specified that "the Letter A No 1, 2 and 3 should be drawn from the best Cocoons of the Filatures of Cossimbuzar, Radnagore, Gonatea, and Commercolly, in preference but not to the exclusion of the other Filature, as those threads seem to be cleaner, and more like the Italian Fabricks".[98] All these efforts of the Court to set up standards of fineness of thread and the sending of samples of these

[96] It is not clear how many cocoons were used in the reeling of the sorts A, B and C respectively. The filatures were simply ordered to use the samples sent from London without any further specifications. It can only be said that A was the finest sort of these three but it was hardly the finest sort that could possibly be made.

[97] The differentiation of silk according to fineness into sorts A, B, and C first appeared in the letters to Bengal in 1785 and rapidly became prevalent. IOR/E/4/640, 25 June 1793, p. 517; IOR/E/4/628, 11 April 1785, p. 552.

[98] IOR/E/4/645A, 27 July 1796, p. 340.

different sorts to the filatures shows the determination of the Court to create standards of thickness which would make it easier for buyers in Britain to choose the exact silk they wanted. It shows that no efforts were spared in analysing the demand in London, or in transmitting the information to Bengal and in setting precise guidelines about the thickness of raw silk to be sent back to Britain.

The second adaptation was the preference given to production of thicker thread. The initial aim of the EEIC was to produce high-quality silk of the fineness of the Italian silk in Bengal. The Company was confident that the improvement of the quality of the raw silk would enable it to outcompete its rivals: "[we] entertain no doubt but that in a short time the Quality of our Merchandize Imported [raw silk] will obtain for us a decided preference over the Importations of any other Country".[99] At first, the focus on the production of thicker thread was driven by the technical difficulties of producing the finest quality thread in the rainy season. It was nearly impossible to produce the finest quality thread in the rainy season because cocoons were more prone to get mouldy and silk threads never dried properly. Therefore the Court directed that in June, July and August silk was "to be spun of 7 to 8, 9 to 10, and 10 to 12 Cocoons" instead of producing coarser silk.[100] The Company still supported the production of the finest sorts of silk but only outside the rainy season and in limited quantity. For instance, in 1785 the Court ordered that:

> 1/5 of the 360,000 small lbs. of Filature Silk abovementioned be wound of equally in quality and size (neither coarser nor finer) than the sample A, 2/5 of

[99] IOR/E/4/628, 16 March 1784, p. 261.

[100] The coarser sorts of silk could not be spun in the rainy season as the silk would be impossible to dry and it would grow mouldy. "If it be made of 5 or 6 Cocoons, it will occasion a prodigious waste in winding off at the Mill, owing to the Bars of the Reel being too hard for so slender a thread, which cannot be loosened therefrom without breaking; and should it be made of 18 to 20 Cocoons the Silk will be black and musty, for want of time to dry it on the Reel, and occasion a Considerable difference in the price in England". IOR/E/4/625, 9 April 1777, pp. 201-3.

> the said 360,000 small lbs. equal in size but not coarser than the sample B and the remaining equal in size to the letter C, if however these assortment should be reeled a little coarser it will not prejudice the sale provided the Silk is wound off perpetually even, round and clean.[101]

Until the late 1780s and early 1790s the preference given to finer thread meant that the production of thicker thread was insufficient to satisfy the demand. The EEIC preferred the production of finer thread notwithstanding the high demand for thicker thread on the British market. Only in 1793 the Court deemed that "the coarse Sort has been the most productive", from the point of view of sales, and ordered that 1/9 of the quantity demanded to be reeled of sort A, 4/9 of sort B, and 4/9 of sort C.[102] The Company favoured the thicker sorts of silk threads as these more readily found market in Britain.

It should be assumed that the Court was successful in adapting the filature system to the social environment of Bengal, especially in adapting the gender-division of labour to the local norms. Although the gender division of labour was not addressed directly by the Company, it is apparent that the changes to the Piedmontese system were far-reaching. In 1788 women represented approximately 72 percent of the workforce employed in filatures in Piedmont.[103] Women were employed as master-reelers, as apprentice-reelers and young girls were assigned the task of watching over the fire under the basins. The reason for employing women as reelers was that they were considered to have more skilful fingers for the task of reeling.[104] In Bengal reeling outside the household was done by Cuttanies – male reelers travelling from village to

[101] IOR/E/4/628, 11 April 1785, p. 552.

[102] IOR/E/4/640, 25 June 1793, p. 517.

[103] Chicco, *La Seta in Piemonte*, p. 213.

[104] Only in Calabria reeling was done by men. Cinzia Capalbo, "Mercato Esterno e Tradizione di Mestiere. La Produzione della Seta a Cosenza tra Sette e Ottocento", *Meridiana* 3, 1988, pp. 73-96; Zanier, 'Pre-Modern European Silk Technology and East Asia', p. 131; Chicco, *La Seta in Piemonte*, pp. 212-13.

village.[105] The Company seemed well-aware of the gender division of labour in silk reeling and relied on male workforce in filatures.[106]

The reason why the EEIC was successful in planning adaptation was that it relied on silk specialists for diffusion of the reeling technologies. Several studies have recognised the role of skilled individuals such as craftsmen, technicians, engineers, and mechanics in transferring foreign technologies.[107] Rosenberg has argued that the role of practitioners is key because not all technical knowledge can be codified or learnt from the technical literature.[108] However, the dependence on silk specialists for transmission of new technologies also had its drawbacks. The EEIC relied on the specialists for technical and commercial changes and even for adapting the system to the social environment in Bengal. However, it could not expect the silk specialists to reform the institutional framework of filature production. The adaptations that the specialists suggested had a technical character; the Company did not employ any personnel with managerial skills to adapt the institutional framework to the conditions of Bengal. In

[105] Goldsmiths' Library [G.L.], 1775 fol.: Williamson, *Proposals*, pp. 17-18.

[106] The issue of employing female reelers was never directly discussed by the Company but it seems that all the reelers employed by the EEIC in Bengal were men.

[107] The role of the movement of journeymen and other skilled artisans in the transfer in the transfer of technologies has been underlined, for instance, by Hilaire-Pérez and Verna and S. R. Epstein. Hilaire-Perez and Verna, 'Dissemination of Technological Knowledge', pp. 544-48, 554-57 and 562; S. R. Epstein, 'Craft Guilds, Apprenticeship, and Technological Change in Preindustrial Europe', *Journal of Economic History* 58 (3), 1998, pp. 702-5. The fact that the transfer of the Piedmontese reeling technologies to Bengal was driven by the EEIC, made it more coordinated and controlled than most early-modern technology transfers. For instance, the silk specialists were employed directly by the Company rather than being given privileges. Also it was the EEIC who retained ownership of the technology, not the specialists. For this reason, it is helpful to compare the silk specialists sent to Bengal with the skilled personnel employed in transfer of technologies in the nineteenth century. For the discussion of the role of skilled individuals in diffusion of steam power in Europe and North America see: Eric H. Robinson, 'The Early Diffusion of Steam Power', *Journal of Economic History* 34 (1), 1974, pp. 91-107.

[108] David J. Jeremy called practitioners "the most efficient agent(s) of international diffusion". David J. Jeremy, *Transatlantic Industrial Revolution: The Diffusion of Textile Technologies between Britain and America, 1790-1830* (Cambridge, MA: MIT Press, 1981), p. 162.

this way the adaptations significantly differed from the economic adaptations of the reeling system in Japan a century later when managerial rather than technical rationales were invoked in changing the system of production.[109] As a consequence, the EEIC faced problems with the implementation of these adaptations. For instance, the silk it obtained quite often did not answer the system of thickness of A, B and C as the thread sent to London was often finer or coarser than what was demanded.[110]

## 7.5. Conclusion

The adaptations of the Piedmontese technology were far from minimal, especially in the case of the technical adaptations necessary to make the technology reliable in Bengal. The EEIC was not oblivious to the need to adapt the Piedmontese reeling technologies to the Bengal context. However, the innovations the Company implemented addressed only the most pressing issues. First, in order to make the Piedmontese technology suitable to the climatic conditions of Bengal, technical alterations were put in place. For this reason brass wheels were substituted for wooden ones and reels started to be made partly of iron. Second, besides technical innovations the Court focused on commercial adaptations such as the regulation of the thickness of the thread and setting-up of a new standard of thickness. Third, the Company innovated the way in which moths were killed inside the cocoons and attempted to innovate the way in which cocoons were

[109] Kiyokawa, 'Transplantation of the European Factory System', p. 33

[110] "We are concerned to observe, that in our last Sale there was some deficiency in this respect. There were complaints of inferiority and particularly of its being generally too coarse. In some case the Sorts, denominated A were not finer than the B should have been, and the same of the B and C. There were also some instances of frauds in package, which ought particularly to be attended to, for preserving the reputation of our Sales. What We allude to, is the making the Coating on outside a Skain of the Letter A when the inside is only B, or perhaps C. The Silk of Collinsons was faulty in this respect, as was also some from Rungpore, a specimen of which is forwarded for your inspection." IOR/E/4/645A, 27 July 1796, p. 355. It should be observed that this problem with the labelling of silk continued from the period before 1770s.

stored. Last, the EEIC was swift in adapting to the gender-division of labour in silk reeling in Bengal.

The alterations to the Piedmontese technology cannot be considered as thorough as the ones implemented in the Japanese silk reeling industry in the following century. The fact that the Company did not alter the system of organization of production or did not innovate the system of quality control derived from the technical input of the silk specialists. The engagement of silk specialists had its obvious advantages as they built on their very detailed knowledge of silk reeling and were thus able to propose suitable alterations. On the other hand, the knowledge of these specialists did not stretch beyond the technical aspects of silk reeling.

# CONCLUSION

The early modern silk industry has received considerably less attention than other industries which has in turn downplayed its importance in early modern economies. Yet, the silk industry pioneered new technologies and new systems of organization of production that only took root in other sectors centuries later. Complex silk reeling machines, for instance, were already in use for the production of silk threads in the early seventeenth century. In contrast, the celebrated machinery for spinning cotton was only invented in Europe in the late eighteenth century. Today, it is believed that cotton spinning technologies heavily borrowed from mechanised silk reeling. Likewise, a centralised system of production was first adopted in textile manufacturing for the reeling of silk. Such early-seventeenth-century technological adoption was driven by demand rather than supply-side conditions: it was the demand for high- and standard-quality silk threads and yarns that led to major technological innovations.

Italy – especially the north-western region of Piedmont – was most successful at producing high-quality silk thread and yarn in Europe. Several other world regions attempted to emulate Piedmont and in the course of the late seventeenth and eighteenth centuries they adopted Italian machinery and Piedmontese system of organization of production. However, such ventures were never successful in the long term. The most common explanation for their failure is the incompatibility of the factor endowments of the country of origin and the country which the technology was transferred to.[1] The

[1] This explanation has been particularly favoured by Yurio Hayami, Vernon W. Rutan, 'Factor Prices and Technical Change in Agricultural Development: The United States and Japan, 1880-1960', *Journal of Political Economy*, 78 (5), 1970, pp. 1115-141; Stephen Broadberry and Bishnuprya Gupta, 'Lancashire, India, and Shifting Competitive Advantage in Cotton Textiles, 1700-1850: The Neglected Role of Factor Prices', *Economic History Review* 62 (2), 2009, pp. 279-305; E. Rothbarth 'Causes of the Superior Efficiency of USA Industry as Compared with British Industry', *Economic Journal*, 56, 1946, pp. 383–

English East India Company also attempted to emulate the methods of reeling silk as practiced in Piedmont and produce 'Bengal Italian raw silk'.

My analysis of the transfer of Piedmontese reeling technology to Bengal shows that the factor endowments of Bengal were not incompatible with the new technology. On the contrary, low labour costs and cheap cocoons represented competitive advantages. Also the return on investment analysis shows that the investment in the new technology was highly profitable. Yet, the venture was not without problems and it ultimately failed. The most significant problem faced by the EEIC was the quality of the reeled silk. Not only did the silk never achieve a quality as high as the Piedmontese product, but Bengal raw silk was also unable to improve its reputation as part of the Bengal silk production continued to be of sub-standard quality. The problem with the quality of the silk had its roots in management practices and systems of organization of production. The Court of Directors paid great attention to the technical aspects of the adoption of the Piedmontese reeling system in Bengal. By relying on skilled silk specialists, the Court implemented many technical and commercial adaptations. However, little or no attention was paid to the organization of production. My analysis shows that the Court failed to create incentives that would motivate the actors involved in Bengal silk production to focus on quality. The Court failed in a field in which the Piedmontese excelled –creating efficient systems for the enforcement of quality.

Overall, by focusing on the transfer of the Piedmontese technology to Bengal in the late eighteenth century my thesis draws attention to the key role of institutions and political economy for the success of production and trade ventures. Contemporary development literature considers transfers of technology to be key to development, yet the scholarship offers only a limited number of detailed analyses of such transfers.

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90, and Robert Allen, *The British Industrial Revolution in Global Perspective* (Cambridge: Cambridge University Press, 2009), passim.

Without appropriate understanding of the factors that underscored the success and failure of technology transfers, it is all but impossible to generalise about the relationship between technology transfers and economic development. Historical cases of technology transfers, such as the one studied in this thesis, offer a perfect opportunity to explore the factors that made a transfer succeed or fail. My thesis considered several factors – factor prices, institutions, and adaptations – and concluded that institutions can be decisive for success of production and trade ventures. New institutional economics has drawn attention to the study of property rights as determinants of development paths and studied the problems of exchange.[2] However, as the thesis shows, other types of institutions affect economic outcomes and institutions need to be considered also at the micro-level. The case of Bengal silk industry shows that the systems of contracts and/or organization of production matter.[3]

[2] See for instance: Douglass C. North, *Institutions, Institutional Change and Economic Performance* (Cambridge: Cambridge University Press, 1990); Daron Acemoglu, Simon Johnson and James A. Robinson, 'The Colonial Origins of Comparative Development: An Empirical Investigation', *The American Economic Review* 91 (5), 2001, pp. 1369-401; Daron Acemoglu, Simon Johnson, and James A. Robinson, 'Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution', *Quarterly Journal of Economics* 117 (4), 2002, pp. 1231-294; Kenneth L. Sokoloff and Stanley L. Engerman, 'History Lessons: Institutions, Factors Endowments, and Path of Development in the New World', *The Journal of Economic Perspectives* 14 (3), 2000, pp. 217-32; Avner Greif, 'The Fundamental Problem of Exchange: A Research Agenda in Historical Institutional Analysis', *European Review of Economic History,* 4 (3), 2000, pp. 251-84; Avner Greif, Paul Milgrom and Barry R. Weingast, 'Coordination, Commitment, and Enforcement: The Case of the Merchant Guild', *Journal of Political Economy* 102 (4), 1994, pp. 745-76; Paul R. Milgrom, Douglass C. North, and Barry R. Weingast, 'The Role of Institutions in Revival of Trade: The Law Merchant Private Judges and Champagne Fairs', *Economics and Politics* 2 (1), 1990, pp. 1-23.

[3] My thesis relies on organizational theory, especially on the work of Oliver Williamson and applies the theory on the case of Bengal filature silk production. For organizational theory see: Oliver E. Williamson, 'The Organization of Work: A Comparative Institutional Assessment', *Journal of Economic Behaviour & Organization* 1 (1), 1980, pp. 5-38; Id., 'Transaction-Cost Economics: The Governance of Contractual Relations', *Journal of Law and Economics* 22 (2), 1979, pp. 233-61; Id., 'The Theory of the Firm as Governance Structure: From Choice to Contract', *Journal of Economic Perspectives* 16 (3), 2002, pp.

The role of political economy should not be underestimated either. The British government's support of the domestic silk industry was a key reason that the Company decided to get involved in silk manufacturing in Bengal. Protectionist policies enabled silk industry to remain one of Britain's seven most important export sectors until the nineteenth century.[4] This was a guarantee for the EEIC that a steady demand for raw silk in Britain would continue. Both the British government's support of the domestic silk industry and the EEIC's involvement in the trade and production of silk in Bengal had their roots in contemporary mercantilist thinking. It was perceived to be in the national interest to supply the British silk weaving industry with raw material from dependent territories. The improvement and expansion of raw silk production in Bengal was presented by the EEIC as an extension of British policies beneficial to British manufactures. Moreover, the EEIC also applied mercantilist ideas to the governing of Bengal: silk production was supposed to allow the most efficient use of factors of production – labour and land – in Bengal. Finally, mercantilist policies supported the government's decision to grant the EEIC the monopoly on trade with Asia as it was expected to aid British exports and create revenues for the British state. The right to trade with Asia also gave the EEIC the right to become a silk manufacturer in Bengal. This right remained in place until 1833 when Parliament revoked the EEIC's trading privileges and stopped the Company's direct involvement in any economic activity in India. Soon after, the Company ceased its silk production and trade activities, and the

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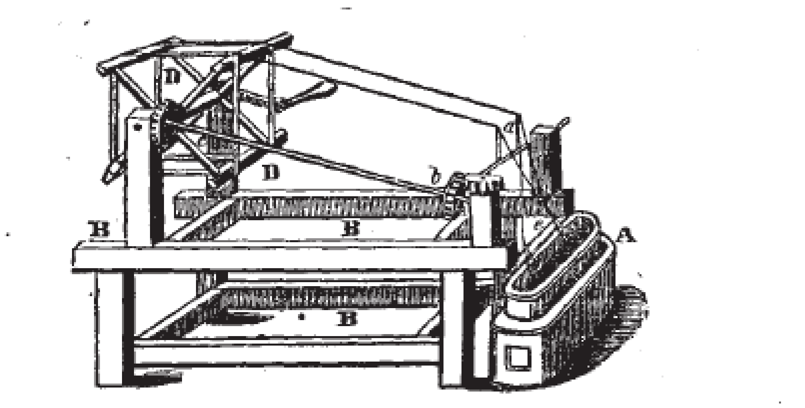
171-95; Id., 'The Vertical Integration of Production: Market Failure Considerations', *American Economic Review* 61 (2), 1971, pp. 112-23.

[4] Although the values of silk exports were not record-breaking, until the nineteenth century they were on par with the other exported items – coal, iron and steel, non-ferrous metals and manufactures, cotton yarns and manufactures, and linen yarn and manufactures – with only woollens and worsteds outstripping the other production. B. R. Mitchell, *British Historical Statistics* (Cambridge: Cambridge University Press, 1988), pp. 469-70.

export of Bengal raw silk to Britain stopped. Thus it was more than economic laws that fundamentally determined the success of the Company's involvement in raw silk production in Bengal.

# APPENDIX A

## Description of the Piedmontese Reeling Machine by Dionysius Lardner




A is a copper boiler about 18 inches long, and six inches deep, set in brick, so as to admit of a charcoal fire being made beneath it: if other fuel be used, a small flue or chimney must be added to carry away the smoke. B is a stout wooden frame whereon the several working parts of the reel are supported. D represents the reel on which the silk is to be wound; *a* is the layer which directs the position of the threads in their passage to the reel; *b* and *c* is the wheel-work which gives motion to this layer. The reel D is merely a wooden spindle, turned by a crank handle at one end, and having four arms mortised at each end within the frame. These arms support the four battens or rails on which the silk is wound. The rails, which are parallel to the axis, are placed at such a distance from it, that they may produce a skein of proper size by the winding of the silk upon them. They are usually so disposed as to pass through the space of one yard at each revolution. One of each of the two sets of arms is made with hinges to fold in the middle of its length, in order that the rail which these two arms support may fall in or approach the centre as occasion may require: this, by diminishing the size of the reel, allows the skeins of silk to be readily slipped off when the winding is completed.

At the end opposite to the handle of the wooden spindle, and within the frame B, there is placed a wheel with twenty-two teeth, giving motion to another wheel *c*, which has about double that number of teeth, and is fixed on the end of the inclined axis *c b*; this, at the opposite end, has a wheel *b* of twenty-two teeth, which gives motion to a horizontal cog-wheel of thirty-five teeth. This last wheel turns upon a fixed pivot in the frame, and has, near to its periphery or outer rim, a pin, to which the wooden rail or layer *a* is attached. The opposite end of this rail plays in a mortise or opening made in the frame B. This layer is furnished at equal distances from the frame with two wire loops or eyes, through which the silk threads are passed in being wound. Now, if motion be given to the horizontal cog-wheel by means of the other wheels and inclined axis, when the handle of the reel is turned, it is evident that this will cause the layer likewise to move to and fro, directing the threads which pass through its wire eyes alternatively to the right and left, though a range equal to the diameter of the horizontal cog-wheel to which it is attached.

The iron bar *e*, which is fixed over the centre of the boiler, is pierced with two holes, though which the threads are led in their passage from the boiler to the layer.

If the thread of each cocoon were reeled separately, it would, from its extreme tenuity, be wholly unfit for the purpose of manufacture: several threads are therefore reeled together. The cocoons which are to be wound being put into water contained in the boiler A, the gummy matter which they possess is softened, so that the unwinding of their threads is facilitated, and at the same time the fibres, which are brought together in the reeling, adhere, and form one strong and smooth thread.[5]

[5] Dionysius Lardner, *A Treatise on the Origin, Progressive Improvement, and Present State of the Silk Manufacture* (Philadelphia: Carey & Lea Chestnut Street, 1832), pp. 155-56.

# APPENDIX B

**The Profits of the English East India Company Generated by Imports of Bengal Raw Silk to Britain, 1786-83**

| Year | Prime Cost Including Freight and Charges | Profit | Loss |
|---|---|---|---|
| 1786 | 192,898 | 5,609 | 0 |
| 1787 | 133,795 | 11,917 | 0 |
| 1788 | 212,357 | 9,531 | 0 |
| 1789 | 268,790 | 12,539 | 0 |
| 1790 | 274,553 | 34,203 | 0 |
| 1791 | 290,419 | 30,236 | 0 |
| 1792 | 378,512 | 13,415 | 0 |
| 1793 | 335,315 | 0 | 53,224 |
| 1794 | 290,419 | 19,324 | 0 |
| 1795 | 378,512 | 2,873 | 0 |
| 1796 | 335,315 | 0 | 7,888 |
| 1797 | 262,917 | 0 | 4,273 |
| 1798 | 277,990 | 44,883 | 0 |
| 1799 | 324,460 | 65,689 | 0 |
| 1800 | 208,969 | 88,676 | 0 |
| 1801 | 262,428 | 132,982 | 0 |
| 1802 | 156,502 | 112,747 | 0 |
| 1803 | 195,117 | 97,542 | 0 |
| **Total** | **4,779,268** | **682,166** | **65,385** |
| **Net Profits** | | | **616,781** |

*Source*: William Milburn, *Oriental Commerce* (London: Black, Perry & Co., 1813), Vol. 2, p. 257.

The total numbers were calculated as the original totals counted by Milburn contain errors.

# APPENDIX C: GLOSSARY

| | |
|---|---|
| Aurung | A textile producing area |
| 'Bengal Italian raw silk' | The term used by the EEIC for the raw silk produced in the Company's Bengal filatures |
| 'Bengal Silk Enterprise' | The term used in this thesis for the EEIC's activities in Bengal raw silk production |
| Board of Trade in Bengal | The principal administrative and managerial body of the EEIC in Bengal |
| Bund | A silk rearing season |
| Country-wound silk | Silk reeled according to the local method used in eighteenth-century Bengal |
| Court of Directors in London | The principal administrative and managerial body of the EEIC |
| Cuttanie | Bengalese reeler travelling to silk rearing villages to reel silk |
| Dadni | Advance payment supplied at the beginning of the season to peasants and artisans for the procurement of a specific quantity and quality of a certain commodity |
| Dellol | Intermediary merchant, the principal broker |
| Dewani | The right to collect tax revenues from Bengal, Bihar and Orissa |
| Filature | Factory-type establishment used for reeling silk |

| | |
|---|---|
| Filature-wound silk | Term used for the silk reeled in the EEIC's filatures in Bengal |
| Gomasta | Merchant agent paid by the EEIC to procure export goods |
| Chassars | Peasants rearing silkworms |
| Knotting of silk | Method proposed by the EEIC's silk specialists to rectify the inequality of threads of country-wound silk to make the threads more round |
| Nacauds | Term used for reelers employed in the re-reeling of country-wound silk |
| Organzine | Silk yarn with a very high twist, used for warp and considered the highest quality silk yarn |
| Putney | Term used interchangeably with country-wound silk |
| Pycars | Intermediary merchants who on behalf of the EEIC advanced money to Chassars and procured cocoons at the end of the rearing seasons |
| Singles | Silk yarn formed from single thread with a single twist |
| 'The choicest goods' | Goods procured in Bengal by the EEIC and considered having the highest potential for profit creation on the European markets |
| Trams | Double twisted silk yarns |
| Winding | Term used interchangeably with reeling in the EEIC's documents |

# APPENDIX D

## Filatures and Basins Owned and Hired by the English East India Company in Bengal, 1832-1833

The figures of the total number of filatures and basins owned and hired by the English East India Company in Bengal for the period 1759-1812 are not known. The figures below are estimates of the Company for 1830s. These figures offer a glimpse of the total number of basins used in filature silk production. It can be expected that the number of the filatures and basins owned and hired by the Company fluctuated in the late eighteenth and early nineteenth centuries because the EEIC often chose to rent its filatures to private induviduals. The most valuable is the figure for the total number of basins as it can be expected that the figure did not change dramatically over the late eighteenth century because the Company did not substantially expand the number of its filatures or their capacity from the late eighteenth century.

**Filatures Hired by the English East India Company, 1832**

| Aurung | Number of Basins | Silk Procured by Contract |
|---:|---:|---:|
| Bauleah | 0 | No |
| Commercolly | 0 | No |
| Kasimbazar | 792 | Yes |
| Hurripaul | 0 | Yes |
| Malda | 1,002 | Unknown |
| Ragnagore | 200 | Unknown |
| Rungpore | 240 | Unknown |
| Santipore | 0 | Yes |
| Soonamooky | 1,350 | Unknown |
| Surdah | 100 | Unknown |
| **Total Number of Basins** | | **3,684** |

LSE Archives, W7204, East India Company, *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London, J.L. Cox, 1836), pp. 219-21.

**Filatures Owned by the English East India Company, 1833**

| Head Factory | Number of Filatures Comprising Head Factory | Number of Filatures Controlled by the Head Factory | Total Number of Basins |
|---|---|---|---|
| Bauleah | 10 | 24 | 2,018 |
| Commercolly | 6 | 7 | 1,716 |
| Kasimbazar | 1 | 0 | 152 |
| Hurripaul | 0 | 6 | 766 |
| Jungypore | 6 | 4 | 923 |
| Malda | 3 | 3 | 480 |
| Ragnagore | 5 | N | 2,594 |
| Rungpore | N | N | 1,300 |
| Santipore | N | N | 800 |
| Soonamooky | N | N | 302 |
| Surdah | N | N | 888 |
| Experimental | 1 | | 100 |
| **Total Number of Basins** | | | **12,039** |

LSE Archives, W7204, East India Company, *Reports and Documents Connected with the Proceedings of the East-India Company in regard to the Culture and Manufacture of Cotton-wool, Raw Silk, and Indigo in India* (London, J.L. Cox, 1836), pp. 215-18. N – signifies that the number is not known.

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