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The Ecology of Cotton in the Eighteenth Century: Possibilities and Potentials

In the early eighteenth century cotton accounted for a very small proportion of Europe's textile production. Linens and woollens dominated the manufacturing sectors of most Western countries and, in the case of Britain, they constituted at least three quarters of the island's exports. A century later this picture had dramatically changed. Cotton was the most important textile in the West, characterised not only by enormous output, but also by a new industrial structure of production. This paper seeks to analyse the well-known story of the rise of the cotton industry in Europe through a close analysis of the 'ecologic' potential and impact of such a fibre. Cotton was the only textile fibre not to be produced within Europe. Why, how and how much did Europe rely on such an 'exotic' raw material to further its process of economic development? This question implies an understanding of how cotton changed the 'textile mix' of most pre-industrial European economies.

1. Textiles in Mid Eighteenth-Century Britain

A possible way of understanding the impact of cotton on the eighteenth-century British textile economy is to provide a brief analysis of the composition of the Island's textile industry at different points in time. How much did cotton change production, consumption and trade during the period between 1750 and 1830? This questions can be addressed only by looking at the relative and absolute weight of the four major natural fibres on which pre-industrial economies could rely: wool, flax and hemp, silk and cotton.

Wool was until the beginning of the nineteenth century a quintessentially European animal fibre. In the 1830s, when data become available, Europe had over 150 million sheep, producing probably more then half a billion pounds of wool a year. Wool was used for the production of sturdy over-garments made of carded or combed wool (woollens and worsteds). Wool textiles were not only the single most important industry in Britain but also

the most important trade commodity, accounting for 90 per cent of all textiles exported from Britain and for a staggering 57 per cent of England and Wales' total exports. In contrast to Continental Europe, linen was not the main British textile industry. If wool textiles were an important item of export, linen was the most important item of import into England accounting for 15 per cent of the Island's total import in the early eighteenth century. Linen was a very European fibre mainly used for under-garments, shirts and bed linen. England relied on the import of Continental linens and linen yarn, and after 1700 also on the production of linen in Scotland and Ireland. Linen came in an impressive variety of types and qualities (at least 50 in the Custom and Excise ledgers).

Silk had traditionally been a niche production in England catering for the making of elite dresses, upholstering, arrases, etc. Our estimates, although rather haphazard because of the small size of the industry, suggest that the total silk production in Britain accounted for less than 5 per cent of all textile production. Cotton textiles are notoriously difficult to estimate, especially for a date as early as 1750. Custom figures tell us that 3.4 million pounds of raw cottons were imported and retained in England and Wales, worth as little as £200,000. This means that the gross value of cotton textiles did not exceed £600,000, making the entire industry as small as silk textile production. Two decades later in 1772, Arthur Young estimated that the English cotton Industry was worth not more than £900,000, circa 5 per cent of the woollen industry. Contemporary estimates thus appear very conservative, especially in the light of more impressionistic accounts that attribute to cotton textiles an important role in changing consumer taste over the eighteenth century. The picture that emerges is of a very small industry, probably smaller than 5 per cent of all textiles (or smaller than 8 per cent if cotton-linen (fustian) mixes are considered).

2. The Political Economy of Textiles

Perhaps more than in any other parts of eighteenth-century Europe, in England wool textile manufacturing was considered to be the motor of the national economy. It had been so for several hundred years and the wool trade symbolised the economic position of England both in relation to continental Europe and the emerging seaborne Empire. The rhetoric of national pride, however, was at odds with reality. According to D.C. Coleman, wool textile manufacturing was 'one of the more technologically stagnant and conservative industries in European economic history'. Stagnation, Coleman reminds us, is a relative concept. It was

mainly related to a lack of substantial output growth and technological innovation in the sector, but surely did not apply to the endless search for new products (including the famous New Draperies). The continuous drive for colour, design, a variety of finishes, weaves, patterns and yarns meant an exhausting search for product innovation to satisfy an increasingly sophisticated consumer demand.

The real challenge of eighteenth-century wool textile manufacturing was not the success of cotton. Wool was the subject of dramatic changes that made the rhetoric of preservation even more difficult to structure coherently. By the mid-eighteenth century it was clear that long staple wool for combed worsted textiles was supplanting the traditional short staple variety used in the production of traditional carded woollens. This process was the result of long-term genetic mutations of the very 'golden fleece' that had provided riches for England for centuries. It was nature, as well as human intention, that was supplanting short staple wool. As Hartwell observed, next to a revolution in cotton, Britain faced a 'revolution in wool' consisting of the lengthening and coarsening of British fleeces. A new breed of sheep, heavier and stronger, was preferred as it produced higher quantities of mutton in a period of high meat prices and increasing population. The situation, however, was far from catastrophic. Estimates indicate that at the beginning of the nineteenth century the internal consumption of wool textiles was more than double than at the end of the seventeenth century. Less positive was its share of the total value of export that passed from 40-50 per cent in the period before 1775, to less than 40 per cent during the remaining part of the century, to fall to 20 per cent in the early nineteenth century.

If cotton appeared to be an alternative and a remedy to the short and long term problems of the woollen and worsted production, it also benefited from a very particular relationship with another established textile: linen. The studies on proto-industry have emphasised the importance of linen in the economy of most pre-industrial European countries. Flax and hemp were cultivated in vast areas from Russia to Silesia, from Flanders to Northern Italy as well as in Ireland and Scotland. The production of linen textiles was a labour intensive process based on the rotting of vegetable raw material, that was put through several stages of refinement followed by spinning, weaving and finishing. Such a productive process, however, was relatively simple and could be performed – especially in its latter stages - within the household.

England heavily depended on the import of large quantities of European linens. The English resented important resources being diverted into Europe when such monies could be better employed in the economic development of the nation. Dependence on Continental Europe was evidenced not only by high imports, but also by the undeniable superiority of continental products. Constant war with Europe and high prices from the 1700s made Britain to pursue a strategy for the development of linen production within its own territory (in Scotland and Ireland). However linen was an unsuitable textile for large-scale production. It was characterised not only by an unsophisticated edge in terms of skills necessary to engage in its production, but also by profound connections with the local agrarian economy and with multi-activity in the countryside.

For a very long time there seemed to have been little consensus in developing another type of textile production. The easiest and most expedite way for ensuring at least a constant per capita supply of textiles was to further the cause of wool and linen. In the seventeenth century, for instance, widely traded woollens were complemented by much lower linens, domestically produced and suited to the lower sorts. In this sense, the binomial wool-flax suited a simple social structure polarised in terms of wealth distribution but still strictly linked to the soil, to pasture and agricultural production. By the late seventeenth century, both these conditions were dramatically changing. Britain was evolving into a much more complex society. Gregory King's attempt to explain the distribution of wealth in England in the 1690s, for instance, shows a dynamic relationship between status and wealth with new mercantile money rendering a clear-cut classification nearly impossible. Historians interested in the progress of material conditions have emphasised the dramatic changes in consumption patterns, the sophistication of demand structures and the creation of new cultural habits. Cotton was of course an integral part of such transformation as it provided, especially in its most luxurious forms, new ways of conceiving the materiality of interiors and the personal appearance of clothing. The development of cotton was possible thanks to a more flexible and much more segmented social structure that considered itself increasingly separated from its agrarian roots.

3. The Potential of Cotton

I have tried to explain the emergence of the cotton industry in Europe, and more precisely in England, in the eighteenth century as a matter of endogenous forces. The relationship between fibres and the economic ideas that contemporaries attributed to them offer some insights into the elements furthering and/or preventing the expansion of a European cotton industry. This is a 'world of possibilities' that must be contextualised by introducing exogenous factors leading this analysis beyond the remit of the old continent and engaging instead with a deeper understanding of cotton as a key for reading the negotiation of power (empire) and resources (ecology) between Europe and other continents.

Such challenges and constraints are here considered by adopting Pomeranz's 'ghost acreages' methodology. Pomeranz offers us a direct measure of the economic and ecologic impact of cotton on British and European textile manufacturing by explaining the rise of cotton manufacturing not so much through its quantification, but by a theoretical exercise of substitution of cotton with other textiles. He thus imagines a situation in which cotton would have not been available and English mills would have had to produce the same quantity of textiles using either flax or wool. His argument with flax is straightforward as he calculates the acres of land necessary to cultivate an amount of flax equivalent to the raw cotton used in the production of cotton textiles. Pomeranz's conclusion (please see longer text for the figures and a critique) is that if wool, rather than flax, had to replace cotton, the impact on British (and European) agriculture would have been much more dramatic. Already in 1810 half of the British agricultural land would have been devoted to pasture for an additional 33.4 million sheep (125 per cent more than the existing stock at the time). Thirty years later Britain would have needed two times its total agricultural land to feed 145 million sheep, six times their actual number (table 1). These are surely impressive figures that suggest the limitations of developing wool textile production at any sustained level in the long term. The development of wool textiles could happen only slowly or by relying on external sources of supply of raw material.

Table 1. *Acreage for Cotton, Wool and Linen*

	Raw cotton imported (in million lb)	Percentage of Britain's agricultural area to be given to cotton cultivation	Thousands of Equivalent acres of land for the cultivation of cotton	Thousand of 'Ghost Acreages' to obtain an amount of linen equivalent to cotton cloth	Thousand of 'Ghost Acreages' to obtain an amount of wool yarn equivalent to cotton yarn
1780	7	0.3	62	28	500
1790	31	1.5	277	124	2,400
1800	56	2.7	500	226	4,300
1810	132	6.6	1,179	561	10,300
1820	151	7.1	1,348	643	11,800
1830	238	10.6	2,125	1,084	18,600
1840	576	23.4	5,142	2,624	45,000
1850	663	26.9	5,919	3,314	51,800

Source: See text.

This theoretical exercise captures a fundamental difference between a vegetable and an animal fibre. Britain heavily relied on vegetable fibres for home consumption of textiles (produced from hemp and flax) and on an animal fibre for the export of wool textiles (woollens, worsteds, mixes and new draperies). This was a rational choice. Energy historians would explain it by referring to the fact that an animal fibre requires an energy intensity (the cost to produce a weight unit as measured in energy units) far superior to that of a vegetable fibre. This is because the animal acts as an energy converter and, by doing so, dissipates a high percentage of energy in the process. If we consider land as a productive factor (and supposing that capital and labour are constant) wool would require 20 times more land than flax to produce one unit of fibre. This simple calculation explains why Britain's choice to specialise in the export of wool textiles (but not raw wool) was rational when compared with the export of linen by many countries on the Continent.

A second set of questions emerges when we think of an economy whose aim is to expand export. This is a scenario in which cotton is not considered as an exogenous opportunity for Britain (either in terms of substitution of Asian cottons, or because of the supplies of raw material, or exogenous technical innovations), but in which markets are available for the sale of textiles (every type of textiles). Let us suppose also that these new and large markets had to be satisfied as quickly as possible, otherwise Britain would have run into a potential competition with other countries (European and extra-European). By continuing with a

strategy based on wool textile export, Britain would have taken a long time before being able to supply these expanding markets. The winning strategy was to switch from an 'intensive' product (high cost of production in land units, high profit returns and relatively small quantities traded) to an 'extensive' product (low cost of production in land units, low profit margins and high quantities traded).

Wool textiles could not have been the optimal choice not only because of their limited capacity to satisfy popular markets, but because it would have created an unprecedented pressure for Britain to switch agricultural to pastoral land. The impact on the existing agrarian economy of the Island would have been profound and the likely outcome would have been a strong rise in wool prices, a loss of competition on international markets and the probable growth of woollen textile production in France, a country with a low density of cattle and sheep. This scenario is plotted within the real historical trajectory of wool production and sheep breeding, up to the 1850s in which c. 95 per cent of all wool used in European textile manufacturing was produced within Europe. By the 1830s, Britain in order to maintain the same level of growth achieved by cotton textiles, would have had to use all of its agricultural land for sheep pasture, and double of that amount less than a decade later. Europe's agriculture would have suffered beyond recovery.

4. How Fast Can It Go?

We might contemplate the possibility of breeding sheep outside Europe, instead of cultivating cotton. This is really not a theoretical possibility but emerged in the nineteenth century when the great plains of North America, the vast interior of Australia or the less hospitable African Cape became enormous reservoirs of wool for European woollen and worsted production. But animal populations grew at constrained rates of increase. Animals are not only inefficient energy converters, but by acting as additional converters over the natural world (photosynthesis), their energy per unit of time is low. This means that elasticity of supply in the physical production of most vegetable fibres is far higher than that of an animal fibre. Supplies of raw cotton could increase much faster than supplies of raw wool.

Two final observations must be made: the first concerning the trajectory of European woollen and worsted manufacture and the second concerning cotton textile manufacturing

outside Europe. As we observed, with the rising demand for textile fibres which accelerated in the 1770s, prices did not rise sharply. This was accomplished firstly by exploiting the production of raw material in the West Indies and the Mediterranean basin and later by establishing slave plantations in the United States. A question remains whether the United States could have developed vast flocks of sheep. Not feasibly because the great plains of the United States were not yet explored and most of the North American continent remained unknown to Europeans. By contrast southern states of the country facing the Atlantic ocean had been colonised first by the French and later by the British. It maintained direct commercial connections with the Sea Islands and was climatically suitable to cotton cultivation. Australia on the other hand had an advantage in the breeding of sheep: its small aboriginal population could be replaced with sheep as grassland could be used for the breeding of inefficient converters. From a labour point of view, while the States could rely on slaves, Australia could not engage with the production of a labour intensive fibre. The Australian production of raw wool grew fast in the thirty years between 1840 and 1870 (causing a resurrection of the wool textile industry in the UK) but such growth could not continue in the long period (table 2). By converse, the production of raw cotton in the US grew steadily over the entire century with the exception of the 1860s when the Civil War *de facto* interrupted international trade.

Table 2. *Decennial Increase in Raw Material Production, 1800-1900*

	American Cotton	Australian Wool
1801-1810	77	-
1811-1820	97	-
1821-1830	94	-
1831-1840	67	-
1841-1850	52	127
1851-1860	37	111
1861-1870	4	102
1871-1880	133	48
1881-1890	66	60
1891-1900	20	- 26

Source: G. Riello, 'Counting sheep: a global perspective on wool, 1800-2000', in G.L. Fontana and G. Gayot, eds., *Wool: Products and Markets, 13th-20th Century* (Padua, 2004), pp. 118; B. Gaye Jaquay, 'The Caribbean cotton production: a historical geography of the region's mysterious crop' (Unpublished Ph.D. Thesis, Texas A&M University, 1997), pp. 99-100.

Finally, we need to consider a counterfactual trajectory of economic development in textile production in areas and countries of the world whose manufacturing economy was already

heavily dependent on cotton textiles, namely India, the Ottoman Empire and China. Any extraordinary expansion of cotton textile manufacturing would have had (in contrast to Europe) a profound impact on local agrarian economies. Both India and the Ottoman Empire were not only large manufacturers of finished cotton cloth but also producers of raw cotton. Historically, the trajectories of their respective cotton industries were on a downward slope, and this has been explained in terms of British competition (especially for India). The case of the Ottoman Empire, where cotton production entered into a declining phase in the eighteenth century, shows us the tension between the production of raw material (mainly for European markets: Britain, but also France and Spain) and the endogenous cotton manufacturing industry. Probably the Ottoman Empire's pressure to produce raw cotton had a negative impact on its capacity to develop as a cotton manufacturing economy. A growing industrial economy can not depend on a growing primary sector.

5. Conclusion

This paper underlines how the distinction between 'natural' and 'artefactual' is somewhat blurred when manufacturing is considered as a process of transformation and use of natural resources. Contrary to established narratives of the birth and growth of the cotton industry, this paper underlines how technological innovation is a necessary but not sufficient condition for economic growth. Technology is able to translate its full potential into actuality only when the resource endowment on which it is applied is sufficiently large and elastic. This is an element that has to be taken into consideration in a period that has been characterised as a turning point from a world of advanced organic economies to 'modern' economies exploiting inorganic sources of energy.

The analyses by Wrigley, Pomeranz, Malanima and others on the ability of Europe to make full use of untapped energy resources in the form of coal, is here examined in terms of raw materials at an 'industry level' rather than considering the economy as a whole. This allows us to connect 'resource-based' explanations of economic development to specific geo-political conditions, both within Europe and at a global level. It also attempts to show how the availability of resources must be 'culturally' recognised as significant within an already established economic set up in which vested interests can act as a barrier for the full exploitation of economic opportunities.