

Diverse Paths to Factory Production, 1780s-1840s:
the Woollen Cloth Industry in the West Riding of Yorkshire
and in the West of the Rhineland (Prussian Rhine-Province)

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Summary

This paper compares the industrial development of the two leading British and German woollen cloth regions in the late 18th and the beginning of the 19th century. It focuses on the implementation of the industrial capitalism's paradigmatic new system of production, the factory system. At the stage of the "Industrial Revolution" the West Riding of Yorkshire and the west of the Rhineland (Prussian Rhine-Province; an industrial district marked by the cities of Aix-la-Chapelle, Düren, Montjoie, and Eupen) had become the predominant industrial woollen cloth regions of their countries. The West Riding was much larger than its German counterpart and its figures of production were, of course, much higher. Both regions pioneered however the mechanisation of the national cloth industries – considered that there was no German nation-state before 1871.

The industrialists of the West Riding introduced spinning and carding machinery about 25 years earlier than the clothiers in the west of the Rhineland. However, about 1830 the scope of the typical factory had become comparable. The industry of the British region was much larger than the cloth industry of the Rhenish region, but the Rhenish factories acquired a comparable range of mechanical production and achieved even a higher degree of vertical integration. Large Rhenish clothiers producing in centralised factories increasingly exploited power machines that operated nearly all kinds of textile machines, nevertheless the looms were still operated by hand. The weavers were mostly centralised into factory workshops, but there was still a remarkable domestic production. Yet this domestic production as well as the artisan production was affiliated to the factory system. As a result of the rapid improvements in the west of the Rhineland, the two regional industries competed seriously on the cloth markets of the world.

The implementation of the factory system in the two regions followed different lines that are analysed in this paper. The differences are explained by the structure of the respective traditional system of cloth production and by different types of products, the similarities are explained by production costs and changing market conditions.

1. Challenging the “Henderson View”

The emergence of industrial capitalism in the late 18th and the beginning 19th century may be considered as a “watershed” in the economic history of Europe with respect to the systems of production and accumulation and to the system of institutional arrangements. While the term “watershed” associates the presumption of a definable place (or time), the transition to industrial capitalism was not a unitary but a multi-faceted development over time and space. Depending on definitions, it lasted nearly one century. However defined, the emergence of industrial capitalism was expressed by economic, technical, social, scientific, and legal change (sometimes political change, too) that fundamentally altered economics and society. One of the most significant characteristics that allow an analytical discrimination between the emerging industrial capitalism and the commercial capitalism of the 15th to the 18th century, though proto-industrial developments should not be underestimated, is the implementation of the factory system. Within only a few decades the new system of production became most important in the highly developed economic regions of Western Europe, and it influenced strongly the process of accumulation. Therefore, the factory system is not only emblematic but also paradigmatic for the “new economy” of industrial capitalism. Yet the factory system was never exclusive, rather there were different interdependent coexisting systems of production. As the industrial sector always consisted of different and, more or less, entangled systems of production, the factory system did not become dominant in terms of employment.

As this perception is mainly an old story of economic and social history, the factory system still remains an important analytical category for research. This concerns not only the sources we can employ. The most important questions regarding the emergence of industrial capitalism are in some way or other related to the “factory”. This is, for instance, true for the supply of capital, labour force and labour relations, entrepreneurial and technical knowledge, and even the development of the markets and their penetration. Thus, the factory system may be regarded as a “core” of industrial capitalism. Used as an analytical category, it unfolds multi-faceted perspectives on different national, regional, or sectoral economic developments of the 18th and 19th century.

The purpose of this paper is not as far-reaching as this general concept. It aims at a comparative analysis of the industrial developments of the two leading British and German woollen cloth regions of the 18th and 19th century, the West Riding of Yorkshire and the west of the Prussian Rhineland, i.e. the region marked by the cities of Aix-la-Chapelle (*Aachen*), Düren, Montjoie, and Eupen. It focuses in particular on the respective implementation of the factory system in the period from the 1780s to the 1840s. Other aspects of the emergence of industrial capitalism, as they are described above, are considered only from the “perspective of the factory”.

This paper does not provide a new interpretation of the industrial development in the West Riding of Yorkshire. This would be too pretentious in view of the thorough and painstaking research, especially by R.G. Wilson¹, David Jenkins², Derek Gregory³, Maxine Berg⁴, or Pat Hudson⁵. In fact, I am indebted to their insightful and controversial interpretations. Unfortunately, economic history has not similarly explored the industrial development of the west of the Rhineland.⁶ Remarkable research has only been done on the re-

1 Wilson, *Gentlemen* (1971); Wilson, *Supremacy* (1973).

2 Jenkins, *Factory* (1973); Jenkins, *West Riding* (1975); Jenkins/Ponting, *British Wool* (1987).

3 Gregory, *Transformation* (1982).

4 Berg, *Age* (1985).

5 Hudson, *Genesis* (1986); Hudson, *Revolution* (1992); Hudson, *Proto-industrialization* (1994).

6 Some of the cloth factories of Aix-la-Chapelle delivered their “archives” as a raw material Ersatz to the World War I authorities;

gional proto-industrial development⁷ pioneered by Herbert Kisch.⁸ Despite the lack of research, there is, remarkably, a predominant interpretation of the German woollen cloth industry that was formulated first in 1954 by William Henderson:

*'At first only slow progress was made in extending the use of modern machinery in the German woollen and worsted industries'*⁹

Henderson probably drew his predication from the literature on the German cotton or worsted industries but, in spite of this little fault, his superficial verdict has never been challenged. The dominant perception of the German woollen cloth industry rather reproduces the "Henderson view": (1.) technical development lagged at least three decades behind the development in Britain, and (2.) industrial progress was very slow.¹⁰

In the course of my ongoing research on regional economic development from 1790 to 1850,¹¹ I have become sceptical towards the "Henderson view" and, advancing, my scepticism grows. The main objective of the following analyses is a preliminary interpretation of the industrial development of the woollen cloth industry of the west of the Rhineland. This paper applies a comparative approach to challenge the "Henderson view": it compares the two industrial developments of the West Riding of Yorkshire and the west of the Rhineland in order to identify the respective specificity and in order to provide an explanation for the sectoral industrial development in the west of the Rhineland. The implementation of the factory system is chosen as a measure of comparison because of the bequeathed empirical evidence (this will be explained in the course of this paper).

In the course of the 18th century both regions had become the dominant woollen cloth regions of the respective "national" cloth trade - bearing in mind that there was no German nation-state before 1871 - albeit the industry (and the region) of the West Riding was much larger than its German counterpart, whereby the Rhenish cloth district was even smaller. The figures of production were, of course, also much higher in the West Riding. This is partly due to the population that was three times larger in the West Riding than in the administrative district of Aix-la-Chapelle (*Regierungsbezirk Aachen*) and six times larger than in the woollen cloth district.

Table 1: Population of the West Riding and of the region Aix-la-Chapelle, Prussian Rhine Province, 1781-1861

	1781	1801	1821	1822	1831	1840	1841	1861
Yorkshire, West Riding*	459083	591000	833000		1013000		1195000	1553000
Region Aix-la-Chapelle				325477	354742	385388		458786
Cloth district of the western Rhine-Province				155843	170000			243737

Source: Deane/Cole, Growth (1967), 103; Mitchell/Deane, Abstract (1971), 20; Reinick, Statistik (1865-1867), vol.3, pp.119, 133.

Janssen, *Geschichte* (1940), 5; and many records were also destroyed during the 2nd World War. Furthermore, the regional firms, the chamber of commerce, and even some cities of the region have been rather unaware of history. There are however some contemporary publications, older dissertations, and popular books that will be noted when they are employed.

⁷ This research provides deep insights into the development of the 18th century, but it stopped in front of the factory door: Ebeling, *Frühindustrialisierung* (1997); Ebeling, *Handwerkswirtschaft* (1997); Ebeling, *Zunft Handwerk* (2000); Ebeling, *Möglichkeiten* (2001); Ebeling, *Entstehung* (2004); Schmidt, *Burtscheid* (1997); Schmidt, *Tuchmanufakturen* (2000); Schmidt, *Standort* (2004).

⁸ Kisch, *Industries* (1959); Kisch, *Impact* (1962); Kisch, *Deterrents* (1964); Kisch, *Textilgewerbe* (1981).

⁹ Henderson, *Britain* (1954), 145.

¹⁰ Blumberg, *Textilindustrie* (1965); Teuteberg, *Wollgewerbe* (1975). This predication includes the west of the Rhineland whose relevance is however acknowledged by the standard publications on the German cloth industry: Blumberg, *Textilindustrie* (1965); also Zunkel, *Gewerbe- und Industrielandschaften* (1986) on the second half of the 19th century.

¹¹ Working title: "*The emergence of a >new economy<*".

Nevertheless, both regions pioneered the respective “national” transition to an industrial economy. Of course, the West Riding industrialists introduced spinning and carding machines about 25 years earlier than the industrialists in the west of the Rhineland. Yet at the end of the 1820s the large clothiers in Aix-la-Chapelle, Burtscheid, Düren, and Eupen, who controlled the larger part of the regional cloth production, produced in centralised factories. They increasingly used power machines that operated nearly all kinds of textile machines (scribbling, carding, slubbing or roving, spinning, raising, shearing, fulling, pressing etc.). Only hand-loom weaving was still carried out in factory workshops as well as in domestic production on putting-out basis. In the 1830s the scope of the typical factory of the two regions became comparable: the cloth factories of the west of the Rhineland acquired a comparable range of mechanical production and they achieved even a higher degree of vertical integration. English woollen cloth products vanished largely from the German markets and the two industries competed seriously on the North American and Asian cloth markets.

The comparison of the West Riding and the west of the Rhineland is not without pitfalls. Especially the products of the two regions, which partly differ, constitute an important problem. Whereas the Rhenish region produced mainly fine cloth, the clothiers of the West Riding produced fine cloth as well (especially in Leeds), but large quantities of the regional production consisted of coarser cloth. Though such coarse cloths were also produced in the Rhenish region, but the quality of the best Rhenish cloths was equal to the West of England superfines.¹² This might suggest a comparison of the west of the Rhineland with the West of England, but then similar difficulties occur. The borderline of the specific British regional division of labour¹³ run criss-cross within the Rhenish industry. - However, a comparison must be based on criteria. And the basic idea of the paper is the comparison of the two industrially leading woollen cloth districts in Britain and Germany.

Spinning, weaving, and finishing cloth is an old technology. It is however not trivial and its products are not homogenous. There is also a relation between the technology used, the extent of the unit of production, and the division of labour on the one hand and the quality of the cloth on the other hand. Section 2 therefore offers general information on the techniques of the woollen cloth production, section 3 provides some terms and definitions (firm, machine, and factory). Section 4 presents a sketch of the two regions’ pre-industrial systems of production. The paper will be continued by an analysis of the introduction of machinery (stages of production, types of machines) that results in a comparison of the structure of the regions’ respective “typical factory” or “typical factories” in section 5. The following section 6 provides information on production, sales, and markets as far as this is possible. The concluding section suggests an explanation for divergence and similarities of the British and the German developments.

2. Production of woollen cloth

Research on the textile industries should not only distinguish different branches based on the raw materials cotton, flax, silk, and wool, but it has also to consider that there are two woollen industries: the worsted industry and the woollen cloth industry. Both are working up sheep’s wool, however, they are using different raw materials that require different techniques of production: worsteds are made of long wool fibres and woollen cloths are made of short wool fibres. These different fibres need a special preparation in order to be spun; there are different processes of spinning, and the cloths are finished differently. The technical

¹² As for the West of England (Gloucestershire, Somerset, Wiltshire) Mann, *Cloth* (1971); Smail, *Merchants* (1999); comparing the English, French, Belgium, and Rhenish woollen cloths: Bienengrüber, *Statistik* (1868), 228.

¹³ Berg, *Age* (1985), 209.

progress in textiles made this less important only in the last decades of the 20th century. The production technique of the worsted industry of the 18th and 19th century was generally more similar to cotton textile manufacturing than to the woollen cloth production that is the only subject of this paper.

The woollen cloth production may in the first instance sufficiently be characterised by four basic processes: 1. selecting the wool; 2. scouring the wool, preparing it for spinning and spinning the yarn; 3. preparing the loom and weaving the yarn; and 4. scouring, fulling and finishing the cloth. Dyeing, the fifth basic process, could be done “in the wool” (after having scoured the wool) or it could be done “in the piece” (i.e. the completed cloth). Weaving coloured yarn allowed, of course, for different patterns, while dyeing “in the piece” allowed for more brilliant and durable colours. Apart from this general statement, dyeing will not be considered further. - The following abstract on the technical process of production employs the impressive cyclopaedia of Abraham Rees (written 1802-1819), contemporary German publications, and modern literature on the woollen cloth industry.¹⁴

The following description of the technical process of production is, of course, simplifying and abstract. All the steps of production could be done (and were done) by manual work, or they could be done (and sometimes were done) with the help of different types of machines. Production differed not only in the levels of labour division or mechanisation, but it was also arranged in several different types of firms. Before the elements of the “pre-industrial” systems of production are examined, the reader will be provided with some terms and definitions.

Selecting the Wool

For all woollen products the quality of the sheep wool used was decisive for the quality of the final product as the clothier could at the utmost reproduce the quality of the respective raw material. If medium quality wool was spun to yarn, woven to cloth, and then finished, the final product could not exceed medium quality; it may even have been of lower quality. Sorting and selecting the wool for the proper purposes was therefore the first and decisive stage of production.¹⁵

Spinning the yarn and the preparations for spinning

The selected wool was subsequently scoured (washed with urine or another mild alkali), even if it had been washed on the sheep before.¹⁶ Afterwards, the wool had first to be dried and then it had to be oiled before being processed further on in order to be ductile. If the clothiers wanted to produce cheaper kinds of cloth, they used rape oil, if they wanted to produce fine cloth, they used olive oil. Willowing or willeying (teazing), scribbling, and carding the wool were the next steps. Willowing meant opening the wool and mixing different wool portions; scribbling and carding were processes similar to each other. By striking the wool with cards the fibres were broken and then lay straight and nearly parallel; the intensity of these processes depended on the wool and the quality of yarn aimed at. [The long fibres used for worsteds are being combed instead of being carded.] Scribbling was a kind of coarse carding that transformed the wool into a thin fibrous web (carded web); This was then carded again with finer cards and separated into “rolls” of two and a half centimetres in diameter and about 60 centimetres¹⁷ in length. Subsequently the carded wool was spun to yarn of different thickness or fineness, and finally it was wound up.

The first process of spinning was slubbing (roving in modern textiles); the “rolls” were joined together and drawn out into a loosely-twisted thread (*Vorgarn*). Afterwards they were spun, whereby the slubbing was slightly drawn out

¹⁴ Rees, *Cyclopaedia* (1819/20); Anonymus, *Feine Tuchmanufaktur* (1796); Johannsen, *Geschichte* (1932); Bühl, *Textilveredelungsindustrie* (1950); Jenkins, *Welsh Woollen* (1969), 1-95; Mann, *Cloth* (1971), 280-307; Jenkins, *West Riding* (1975), 110pp. A short glossary in Jenkins/Ponting, *British Wool* (1987), 332-353, with a short survey on the production process, 18-26.

¹⁵ *Art. Wool* [Rees *Cyclopaedia*] (1819); Anonymus, *Feine Tuchmanufaktur* (1796).

¹⁶ On the following, see: Anonymus, *Feine Tuchmanufaktur* (1796); *Art. Woollen manufacture* [Rees *Cyclopaedia*] (1819); Jenkins, *Welsh Woollen* (1969), 1-63; Mann, *Cloth* (1971), 280-290. Wool from Spain usually had been washed when it was sold, but the clothiers did not regard every type of wool as being sufficiently clean, Anonymus, *Feine Tuchmanufaktur* (1796).

¹⁷ *Art. Woollen manufacture* [Rees *Cyclopaedia*] (1819).

and twisted. Spinning the slubbing required careful handling, because carded wool was not very extendable compared to cotton fibres or worsted wool. Therefore, the spinner could easily overdraw and break the slubbing. This was the reason that made the adaptation of cotton spinning machinery in the woollen cloth industry much more difficult than in the worsted industries.

Weaving and preparing the yarn and the loom

Weaving means crossing or interlacing two types of threads. They are usually arranged in right angles to each other. One type of yarn is called warp (or chain); these yarns are running parallel lengthwise in the cloth from one end to the other. It is fixed between two bars of the loom. The other type of yarn, the weft, is one continuous thread running across the warp being woven alternately above and below the threads of the warp that had to be steadier than the weft.¹⁸ Therefore, warp and weft were not only spun in a different way, but the warp had also to be sized or strengthened to prevent it from breaking during weaving.

At first, the threads of the warp were arranged (they were grouped and laid parallel) onto a warp bar to allow an easier hoisting onto the warp beam. The assembled threads had to be scoured from oil and grease first. After they had dried, they were sized. The weavers used different techniques however. The warp for fine cloth had to be sized with glue, and then it had to be dried again. The threads were arranged on the warp beam that was later installed into the loom. Each of the threads, totalling up to 3,000 or 4,000, had to be fixed at the warp beam and, when the warp beam was installed into the loom, they had to be fixed with equal tension at the cloth beam of the loom.

The weft was only wound on a quill that could turn freely in the shuttle that moved the weft through the different threads of the warp.¹⁹

Scouring, fulling and finishing the cloth²⁰

Finishing, the third stage of production, was probably the most diverse stage because each kind of cloth was treated differently and it was the most extensive process taking quite a lot of time. The woven cloth was first scoured again from oil, grease, and glue left from the spinning of weft and from the sizing of the warp. In a second step the cloth was then fulling, that is the '*closing together of the threads of woven woollen fabrics by pressing and kneding with the help of soap or acid liquor*'²¹ in order to felt the fibres and to shrink the cloth. Since the late Middle Ages both processes were carried out in the so-called fulling mill. Its machinery consisted of water wheels that powered wooden hammers or fulling-stocks working into a hutch or trough filled with water that should be hot or warm if possible. Usually different troughs and hammers were used either for scouring or for fulling because the processes were different: while the hammers used for scouring should only move the cloth permanently within the trough, the hammers or fulling-stocks of the fulling process should stamp, push, and squeeze the cloth in order to shrink it. Scouring required the use of alkaline fuller's earth; fine-cloth was usually fulling with soap. Fulling required experience and skill as the fullers had to ensure that the cloth shrank evenly to a predefined measure, usually around 30% in the length and 40% in the breadth. This work was time-consuming. After each two or three hours the fuller had to take the cloth out of the trough and he had to soap it again. At least the cloth had to be washed in clear water. The process of fulling (or milling) took around 12 hours; scouring took also several hours. Moreover, the cloth had to be tenter after both treatments, it was dried being fixed onto large tenter racks whereby it was stretched a little bit to prevent it against further shrinkage.

After being tented the first time and before being fulling, every part of the cloth was examined accurately in order to find faults (e.g. little holes) that needed mending or knots or little objects that had to be removed.²² These defects could not be detected after the fibres were felted in the fulling-mill, but they had to be fixed before the cloth was

¹⁸ Therefore some kinds of mixed cloth used a cotton warp.

¹⁹ *Art. Weaving [Rees Cyclopaedia]* (1819); *Art. Woollen manufacture [Rees Cyclopaedia]* (1819); Barlow, *History* (1878); Jenkins, *Welsh Woollen* (1969), 64-81; Mann, *Cloth* (1971), 290-293.

²⁰ Anonymus, *Feine Tuchmanufaktur* (1796); *Art. Fulling [Rees Cyclopaedia]* (1819); *Art. Woollen manufacture [Rees Cyclopaedia]* (1819); Bühl, *Textilveredelungsindustrie* (1950); Jenkins, *Welsh Woollen* (1969), 81-88; Mann, *Cloth* (1971), 293-307.

²¹ E. Kilburn Scott: *Early Cloth Fulling and its Machinery*, in: Transactions of the Newcomen Society XII (1931/2), 1, quoted by Jenkins, *Welsh Woollen* (1969), 81.

²² This process was called burling.

dressed. Dressing means raising the nap of the wet cloth with the help of teasels in order to lift up loose fibres of the cloth. If there were still holes or knots in the cloth, it could be ruined. The cloth was dressed several times in different directions in order to lift up straight all loose fibres. When all fibres were raised the cloth could be sheared. Shearing required skilled workmanship and a careful handling; all the raised fibres of the cloth had to be cut to the same level, but the cloth that still counted up to 1,5 meters in the breadth (broadcloth) was not supposed to be sliced. Depending on the quality of the cloth raising and shearing was repeated several times. Therefore (and to recuperate from the hard work of shearing while they were dressing again), dressing and shearing was usually done by the same persons.

Shearing was followed by another survey of the cloth, uncovered faults were repaired. Afterwards a final brushing, also called raising, produced the final nap on the cloth. All the loose cuttings were removed and all fibres were laid one way. Wet brushing gave a “dress finish” to the cloth while dry brushing gave it a “blanket finish”. The cloth was not yet ready for sales. It still had to be pressed before. The cloth was “*folded backwards and forwards at every yard, so as to form a pack on the board of a screw-press; and between every fold sheets of glazed paper are placed, so that no part of the surface of the cloth can come in contact; also at every twenty yards three hot iron plates are put in between the folds ...*”²³ Pressing gave the cloth a smooth and even surface.

3. Working definitions: the firm, the machine, and the factory

3.1 The firm

The economy of industrial capitalism is marked by the transition from artisan manufacturing and merchants putting-out to factory production and to the industrial enterprise. This did however not eliminate the traditional systems of production and economic organisation whose share in the goods-producing sector became less important. Artisan manufacturers and merchants went more and more into (other) fields of production matching their respective competitive advantages or they entered the factories.

It is necessary to distinguish between two basic types of industrial organisations: (1) the firm (the enterprise) as an organisation with an economic function, and (2) the unit of production as an organisation with technical and organisational functions. These are, of course, basic models (*Idealtypen*) in the sense of Max Weber, whereas in the real world the unit of production may be a firm, too. The functional distinction between the firm and the unit of production is nevertheless decisive for economic historical analysis.

The conception offered considers the firm as a single economic institution detached from the household of the entrepreneur that provides goods or services to the markets.²⁴ The definition is based on the economic function of the firm and it neglects, at first, specific markets or structures of the firm. This simple definition forms the basis for a more detailed distinction, if necessary, e.g. according to structures of ownership (partnership, limited, joint-stock company, etc.) and control (entrepreneurial, managerial, etc.). In contrast to this, the unit of production defined by technical and organisational criteria provides goods or services that are either offered to the markets or that are processed further on in other units of production of the respective firm. Units of production are not necessarily market participants. Based on this categorical difference it is possible to distinguish different units of production (e.g. artisan workshops, factories). Units of production are producing basically marketable goods or services while firms provide the markets with goods or services they do not necessarily produce themselves.

Concerning the woollen cloth industry in the 18th and 19th century the marketable goods were, e.g., wool, slubbings, yarn, or cloth. The classical case of the entity of the firm and the unit of production was the artisan workshop where the clothier produced yarn and cloth with the help of apprentices and journeymen and

²³ Art. *Woollen manufacture* [Rees *Cyclopaedia*] (1819).

²⁴ Similar to European Court, decision T-319/99, 4 March 2003.

then sold his product on the local or regional markets. The extreme opposite was the firm without any unit of production, e.g. cloth merchants employing only putting-out work and artisans but controlling their product all the time; in the second half of the 19th century some companies, just like modern trademark companies, even employed other factories to produce their products.²⁵

3.2 The machine

Some types of machines, the water mill and the wind mill, had already been in use for several centuries when the spinning jenny, the waterframe, or Watt's steam-engine, to name only some symbols of the so-called industrial revolution, were invented. The best example concerning the cloth industry is probably the fulling mill that existed already in the late Middle Ages. In fact, these simple mills facilitated a higher production and better quality than human handwork before (footwork in the cloth production), but these mills did not implement an industrial revolution.²⁶ In contrast to these mills, the new spinning machines, though being very simple, were more sophisticated. They facilitated a substitution of human labour that had been unknown until then, and, by doing this, they increased both labour productivity and production. The scribbling and carding machines, the gig-mills and the shearing machine had similar economic effects; the substitution of manual labour by machines was a crucial process during the late 18th and beginning 19th century.

The argument concentrates on the novelty of the machines that Marx has termed "*tool or working machines*". The working man, Marx argued, has only two hands and two feet; but the machine, being emancipated from these organic limits, could simultaneously move a large number of tools:

*'In Germany, they tried at first to make one spinner work two spinning wheels, that is, to work simultaneously with both hands and both feet. This was too difficult. Later, a treadle spinning wheel with two spindles was invented, but adepts in spinning, who could spin two threads at once, were almost as scarce as two-headed men. The jenny on the other hand, even at its very birth, spun with twelve to eighteen spindles [...]'*²⁷

At the first stage of the industrial development, the machines substituted labour regardless of the type of moving power (human, water, horse, steam, etc.). But soon the combination of the work machine and a powerful prime mover potentiated a much higher productivity. Both, the prime mover and the transmission, had been used long before (water mills and wind mills, steam engines as water hoisting machines in the pits). But only the technical feasibility and the availability of the work machine allowed the use of the prime mover and the transmission in the mechanical production.²⁸

*'These two first parts of the whole mechanism are there solely for putting the working machines in motion, by means of which motion the subject of labour is seized upon and modified as desired. The tool or working machine is that part of the machinery with which the industrial revolution of the eighteenth century started. And to this day it constantly serves as such a starting point whenever a handicraft, or a manufacture, is turned into an industry carried on by machinery.'*²⁹

The different concepts of the industrial revolution cannot be discussed here.³⁰ Also the technical correctness of the Marxian definition of the "*machine*" that fits more or less with the development of the 18th century will not be reconsidered critically at this point. What is crucial for my argument is, first, that the im-

²⁵ Ritter, *Tuchindustrie* (1895), 132.

²⁶ Wachs, *Bedeutung* (1909), 57; Hudson, *Proto-industrialization* (1994), 46-47.

²⁷ Marx, *Kapital, Bd. 1* (1977 [1867]), 393-94.

²⁸ On the steam engine, see the impressive interpretation of von Tunzelmann, *Power* (1978).

²⁹ Marx, *Kapital, Bd. 1* (1977 [1867]), 393.

³⁰ E.g. the concepts of the technologically driven "*Unbound Prometheus*" (D. Landes), of the industrious revolution (J. de Vries), or of proto-industry as the "first stage of industrialisation" (F. Mendels); see introducing: Mokyr, *Introduction* (1999).

plementation of the spinning machine and, often underestimated, of the machines for wool preparation changed the traditional systems of production (and accumulation) of the woollen cloth industry dramatically. And, secondly, despite similar technological progress, the development in the west of the Rhineland differed crucially from that in the West Riding. The implementation of machinery rather resulted in different types of firms and even different units of production. That asks for an explanation.

3.3 *The factory*

The predominant unit of production of industrial capitalism was the factory. There are an almost uncountable number of definitions of the factory, of which many include a catalogue of unnecessary criteria.³¹ I will propose another one that includes only necessary and sufficient criteria in order to permit a distinction of the factory from manufactures, artisan workshops, and domestic production. While each single criteria was not necessarily new and some also apply to other units of production, the novelty of the factory of industrial capitalism was the *coincidence* of the following four criteria: (1) centralised production employing wage labour;³² (2) coordinated division of labour; (3) employment of mechanical tools (work machines); and (4) employment of prime movers to operate the tool or work machines.³³ It has been explained above that the use of a prime mover was no essential criteria for a machine. For the factory, however, it is a necessity.³⁴

The productivity of the machines for spinning and carding as well as for finishing cloth could only be utilised efficiently if sufficient power was available. Systems of different machines, in particular, afforded more powerful prime movers. Yet it depended on available natural resources whether this meant steam engines. It is therefore possible to recognise different regional musters. But even if clothiers possessed water mills and if they were licensed to use water, they increasingly made use of steam engines in order to detach production from climatic influence (frost, water shortage, etc.), to operate capital equipment continuously, and to accelerate capital refunding.

The contemporaries used very different terms of reference. For instance, the British factory inspectors seemingly used the term “factory” if at least one process of the woollen manufacturing was being carried out with the help of steam or water engines,³⁵ while the Prussian *Gewerbe-Tabelle* (*table of manufacturers*) of the administrative district of Aix-la-Chapelle (*Regierungsbezirk Aachen*), collected every third year since 1837, regarded any establishment that employed machinery and/or any establishment that covered different stages of production as a “factory”. These different definitions raise important questions in terms of a comparative approach. For instance, in the British context a dyer, working with the help of a journeyman and apprentices and employing a small water wheel, was regarded as a “mill” or as a “factory” but not a clothier employing spinning jennies, looms, shearing frames and perhaps two hundred workers in his establishment. The Prussian statistic counted converse. I will go more into details about this issue during my discussion of the statistical accounts.

³¹ E.g. Wehler, *Gesellschaftsgeschichte*, Bd. 1 (1987), 115pp. names eight criteria; see also Jenkins, *West Riding* (1975), 11, for different definitions of the factory.

³² Wage labour was of course only to be found in capitalist societies.

³³ In the first half of the 19th century this means the use of a central prime mover as steam engine or water engine via a transmission to the work machines.

³⁴ See e.g. von Tunzelmann, *Power* (1978). It may be noteworthy that already Marx was most sceptic towards an overestimation of the steam engine, Marx, *Kapital*, Bd. 1 (1977 [1867]), 399-400.

³⁵ Jenkins, *West Riding* (1975), 11.

4. “Pre-industrial” systems of production

When the factory system emerged in the late 18th century, both regions, the West Riding and the west of the Rhineland, had already a long and famous tradition of commercial woollen cloth production.³⁶ It might be a legend that cloth production in Aix-la-Chapelle began in the times of Charles the Great, but the cloth production was already well-known in the 13th century. From then on Aix-la-Chapelle was regarded as the German ‘*capital of cloths*’.³⁷ The many ups and downs in the following centuries cannot be explained here. But it is necessary to sketch at least the structure of the 18th century’s “pre-industrial” systems of cloth production. We will see later that these different systems of production contributed to the different paths of the respective industrial development. The chosen perspective on the development of the woollen cloth industry in the 18th century is, of course, strictly limited, as it refers only to developments that brought about the factory system of industrial capitalism. This assessment is emphasised by using the term “pre-industrial” that is attributed to the 18th century’s systems of production. The term should not be misconceived as some teleological conception of history.³⁸ The term “pre-industrial” rather reflects the limits of the scope of this paper that is not concerned with proto-industrial economic development³⁹, but with the implementation of the factory system.

The towns were the centres of production in both regions. And, apart from local specifics, cloth-maker corporations and the guild system were crucial elements of the institutional arrangements until the 18th century. These arrangements were, of course, not the same. But the development took the same direction. In the West Riding the cloth-maker corporations and the guild system vanished in the early 18th century; the system of apprenticeship (seven years before settling as a master clothier) was however still alive. It was, more or less, respected until the end of the Napoleonic Wars and prevailed much longer than in other places in England.⁴⁰ In the west of the Rhineland the cloth-maker corporations and the guild system were first abolished by the French occupation of 1794; and they were never re-established. Yet, at that time the traditional institutional arrangements were already disintegrated. They had eroded from inside and because of competition. Since decades clothiers and shearers had evaded the guild regulations⁴¹ in order to compete with the successful guild-free clothiers of Montjoie, Eupen, Burtscheid, and Vaals that had risen up since the early 18th century. Nevertheless, the guilds had still a strong influence.

Both regions originally provided appropriate natural resources for cloth production, especially sufficient supply and quality of water. In the West Riding water was a ubiquity and the hills provided an important natural asset for the water mills. The west of the Rhineland was privileged with lime-free water that was indispensable for the finest cloth qualities, and the warm springs in the hinterland of Aix-la-Chapelle provided excellent conditions for finishing and dyeing the cloth. With the extension of manufacturing in the

³⁶ On the West Riding see: Heaton, *Yorkshire* (1965), Lipson, *Woollen Industries* (1921); on the west of the Rhineland there is no comprehensive book, see: Kley, *Geschichte* (1916); Seidl, *Wollenindustrie* (1923); Fehr, *Geschichte* (1927); Barkhausen, *Tuchindustrie* (1925); Weingarten, *Tuchindustrie* (1922).

³⁷ Viebahn, *Leinen- und Wollmanufakturen* (1846), 37; quote: Viebahn, *Statistik*, 3 (1868), 915.

³⁸ The general assumption that historical development is not predetermined but rather contingent is, of course, a philosophical conception, but there is no convictive scientific explanation for teleological conception of history. History itself denounces e.g. the Hegelian perspective of modernisation theory that seems to be more a model than an explanation for the western part of the world.

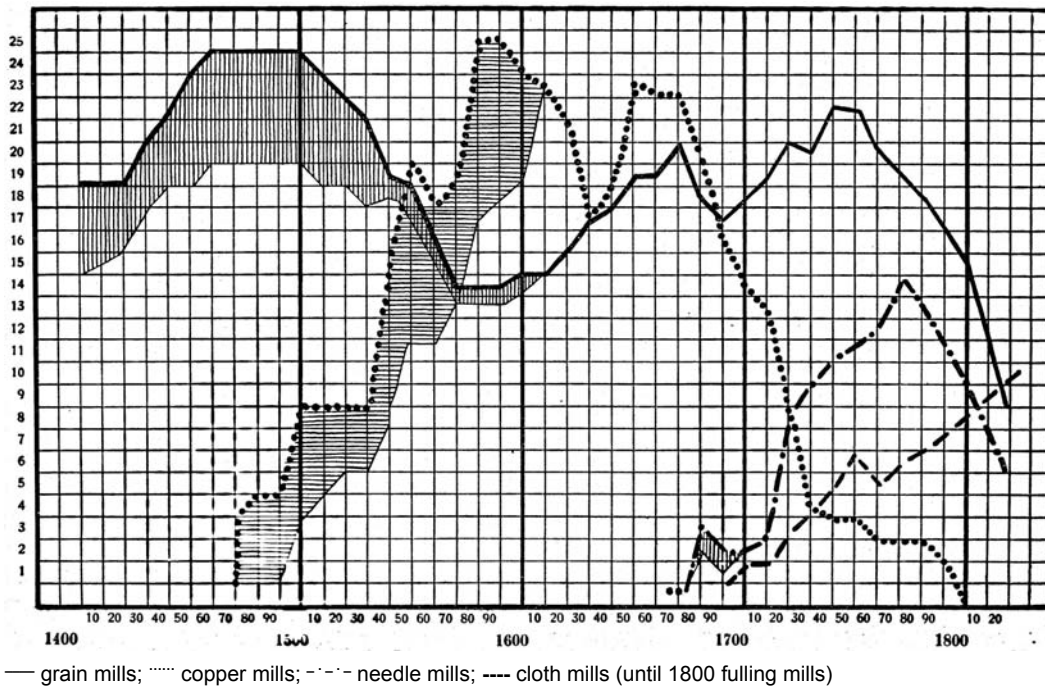
³⁹ It is not necessary to discuss whether “proto-industry” is an ‘useful abstraction’ or just a ‘concept to many’ (Coleman). The concept of proto-industrialisation has generated many new insights and it has broadened the perspective towards the emergence of capitalism and industrial capitalism.

⁴⁰ Heaton, *Yorkshire* (1965), 301pp.; Lipson, *Woollen Industries* (1921), 74pp.

⁴¹ See: Heizmann, *Lage* (1923), 14-15, 42-43; Seidl, *Wollenindustrie* (1923), 46-47; Kermann, *Manufakturen* (1972), 118-19; Winzen, *Auseinandersetzungen* (1994); Ebeling, *Handwerkswirtschaft* (1997), 327pp.; Pfister, *Produktionsregimes* (2004), 170-175; Anonymus, *[Clermont] Freymüthige Betrachtungen* (1788).

18th century the narrow brooks of Aix-la-Chapelle could no longer provide all branches of the local industry, and water supply became a permanent problem of cloth production. *Figure 1* on the water mills in Aix-la-Chapelle suggests that the woollen cloth industry of the 18th century was very competitive compared with the other industries, as the cloth industry increased the number of water mills employed on account of the other industries.

Figure 1: Water mills in the city of Aix-la Capelle, 1400-1800



Source: Paffen, *Wasserkraft* (1928), 107.

There were, however, also major differences in the industrial structure and the institutional arrangements of the two regions. The cloth region of Aix-la-Chapelle was circled and it was crossed through by toll bars and toll bridges and by different custom regimes. Therefore and due to slow land traffic, it was expensive and difficult to visit the wool markets (e.g. in Breslau) or the cloth fairs (e.g. in Frankfurt). In contrast to this, the West Riding was situated in a national single market. Also travelling was easier in England. The most important industrial difference was that until the 1850s woollen cloth was by far the most important textile product in the region around Aix-la-Chapelle. In the West Riding the cloth industry was supplemented by the worsted industry that had been established in the 18th century and that had grown rapidly since the 1770s.

Starting from these general remarks I will outline the “pre-industrial” systems of production, first in the West Riding, then in the west of the Rhineland.

4.1 West Riding, Yorkshire

The Parliamentary Papers of 1806 and other years⁴² provide a comprehensive account of the Yorkshire woollen industry. The reports originate from the period of the transition to industrial capitalism and offer an applicable description of the “pre-industrial” system of production. Heaton resumes in his principle

⁴² Report of Select Committee appointed to consider the state of the woollen manufacture in England, 1806, vol. III. Research on the West Riding is largely based on these accounts. They have already been thoroughly exploited by Clapham, *Woollen* (1913) and in 1920 by Heaton, *Yorkshire* (1965).

study on the Yorkshire woollen and worsted industries that in the end of the 18th century the woollen industry of the West Riding was ‘*still largely in the hands of small independent clothiers*’.⁴³ He also identifies a group of medium-sized clothiers and a group of big clothiers. The first two groups formed the system of “domestic manufacture”, in which the clothiers not only owned their looms, but also the material they worked on.⁴⁴

The small clothier was an independent producer with a family business who operated his own spinning and weaving equipment. Most of them were provided with a parcel of land for farming as a sideline. The clothier bought the wool from wool-dealers or on the town markets. His wife and children carded and spun the wool that he wove to cloth (only if the own family could not sufficiently supply the clothier with yarn, some wool was put-out to be spun in neighbouring cottages). The clothier also dyed the wool with the help of an apprentice, a journeyman, or a son. He wove the cloth and gave it to a fulling mill. Afterwards he sold the fulled cloth in its unfinished condition. He could sell it to cloth merchants, but he had also easy access to the cloth markets that were organised as street markets or cloth halls. Only a small amount of money was necessary to enter such a business; the wooden looms were cheaply bought and sometimes even made by the clothier himself. He needed a small amount of money because he had to buy the wool, to fee the fuller, and, if necessary, to pay wage for external help. These conditions restricted the productivity of these small clothiers. It is estimated that most of them could produce only one or two pieces of cloth a week - if they worked hard and continuously.⁴⁵ An important element of the domestic system was the domestic clothiers’ real property, which, though generally small, offered the possibility of credit.

During the 18th century a class of medium-sized clothiers had developed from the small clothiers, some of whom even produced twenty cloths a week. This class of clothiers employed a greater number of journeymen and apprentices. Spinning and weaving was carried out in the shop of the clothier and, depending on the order situation, by domestic workers, too. The organisation of work differed a little bit from the small business clothiers. In the medium-sized business the clothier was more concerned with the purchase of raw material, organisation of work, and selling his products. Nevertheless, he usually dyed his wool or the cloth “in the piece” and he operated the loom at least from time to time.⁴⁶ A third group of clothiers, the merchant clothiers, established their business especially in the larger towns.

There was no standard size of a clothiers business, but it is estimated that ‘*on an average a clothier probably employed at least ten persons*’.⁴⁷ Nevertheless, the degree of integration of production into the firm was widely independent from scale: The local markets or wool-dealers provided the clothier with raw material, no matter if he was running a small or a medium-sized business. The clothier organised carding, spinning, and weaving. For the purpose of lower qualities the clothier even dyed the wool himself. The production was situated in the workshop of the clothier who temporarily extended his capacity of production by means of employing domestic workers; they received the material from the clothier and they were paid by piece wage. But generally the system of the West Riding was rather a *Kaufsystem* than a putting-out system. There were at least 3.500 broadcloth manufacturers in the mid 18th century West Riding.⁴⁸ The smaller and medium-sized clothiers provided the local markets, especially the cloth halls erected in the 18th century,

⁴³ Heaton, *Yorkshire* (1965), 293.

⁴⁴ Lipson, *Woollen Industries* (1921), 71-72.

⁴⁵ Heaton, *Yorkshire* (1965), 294-95; Lipson, *Woollen Industries* (1921), 71-78; Jenkins, *West Riding* (1975), 5-6.

⁴⁶ Heaton gives two examples; in one case the clothier employed journeymen (spinners and weavers) working at home and paid by piece wage, in another case, the clothier owned a spinning jenny and three looms that were operated in his own workshop; Heaton, *Yorkshire* (1965), 295-96.

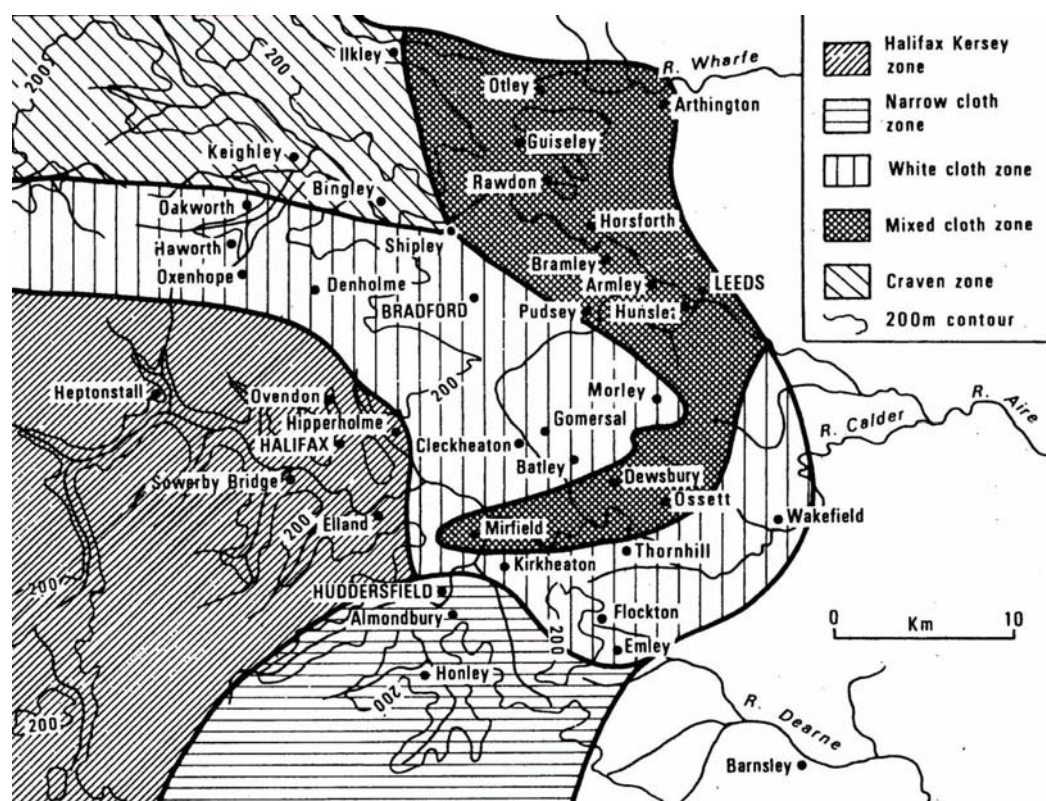
⁴⁷ Lipson, *Woollen Industries* (1921), 72.

⁴⁸ Hudson, *Genesis* (1986), 61.

with fulled, but unfinished cloth. Fulling was done in specialised fulling mills for wage or for a commission. Dyeing in the piece was also a specialised business and dressing the cloth, too (raising, shearing, tentering, and pressing). Sometimes the dyers were also engaged in dressing. But usually the cloth dressers were independent artisans with their own capital who were not working for a commission.⁴⁹ The main customers of the clothiers were the merchants. It is possible to distinguish between three groups: travelling merchants supplying shops all over England, merchants selling unfinished cloth to the London drapers with the help of factors at the London Blackwell Hall, and, finally, the exporters.⁵⁰

The merchants of this last group had established their business in the larger towns and they were mostly involved in dyeing and finishing as well. These merchant clothiers produced finished cloth and they employed even dyers or cloth-dressers (shearmen). Many of them employed artisan master-dressers who were working independently with their journeymen and apprentices and with their own tools.⁵¹ Others ran larger workshops or even manufactories, where they had gathered dozens of journeymen and apprentices, a number of looms, shearing frames, dressing equipment, etc. Also domestic spinners and weavers were integrated into this system of production. Fulling was almost entirely done in fulling mills operated by fullers, who usually did not own the fulling mill. The fuller rather rented it from manorial landholders.

Figure 2: Woollen cloth producing zones, West Riding early 18th century



Source: Hudson, *Genesis* (1986), 27.

⁴⁹ Hudson, *Genesis* (1986), 31-32.

⁵⁰ Lipson, *Woollen Industries* (1921), 82pp.

⁵¹ Small, *Merchants* (1999), 67-68 argues that they 'were incorporated within the firm' but this is probably overestimating the integration; see below on the definition of machine, factory, and firm.

By the end of the 18th century the West Riding had become the leading British cloth region, whereby different production zones in the West Riding can be distinguished (*Figure 2*). According to Phillis Dean, Yorkshire accounted for 60% of the national output and the West Riding was by far the most important cloth region of Yorkshire.⁵² Modern research argues that product specialisation, the concentration on goods of lower and medium quality, that enabled the regional clothiers to meet the competition of cotton, was the region's competitive advantage and the older explanation that was focused on natural resources (water, coal) should not be overestimated.⁵³ The economy described was still an economy with low fixed costs. Less than 6% of the investments of the smaller and medium sized clothiers were bound to spinning or weaving tools. 80-90% of the investments went into wool purchase.⁵⁴

3.2 The west of the Rhineland [since 1819: Regierungsbezirk Aachen (administrative district Aix-la-Chapelle), Prussian Rhine-Province]

Since the end of the 17th century, the putting-out system based on domestic work had been established as a new system of production in the gild-free towns of Eupen⁵⁵, Montjoie⁵⁶, Burtscheid⁵⁷, and Vaals in the west of the Rhineland, while the cloth-maker and shearer guilds could maintain the traditional position of artisan manufacture in the traditional regional centres of cloth production in Aix-la-Chapelle⁵⁸ and Düren⁵⁹. However, even artisan workshops in Aix-la-Chapelle were integrated into the putting-out system. Respectively, the artisan manufactures employed domestic labour apart from journeyman and apprentices, especially for spinning. The complex developments in the different towns over time cannot be analysed here and the following summary is, therefore, a simplifying model of the regional systems of production at the end of the 18th century. It is based on the manifold literature on the regional proto-industry and artisan manufacturing.⁶⁰

The central position in the woollen cloth industry of Aix-la-Chapelle (that was regulated by guilds⁶¹) was occupied by the cloth-merchants. They took the economic risk, they possessed the commercial know-how of inter-regional and international trade, and they owned the necessary wealth to finance the purchase of the raw materials.⁶² The cloth-merchant, contemporarily also called *fabricant* or *entrepreneur*,⁶³ purchased

⁵² Deane, *Output* (1957), 203-215.

⁵³ Hudson, *Genesis* (1986); Jenkins, *West Riding* (1975), 6.

⁵⁴ Hudson, *Genesis* (1986), 28.

⁵⁵ Anonymus, *Feine Tuchmanufaktur* (1796); Hermanns, *Tuschscherer* (1982); Henkel, *Taglohn* (1989); Anonymus, *Eupener Tuchgewerbe* (2000).

⁵⁶ Weingarten, *Tuchindustrie* (1922); Barkhausen, *Tuchindustrie* (1925).

⁵⁷ Schmidt, *Burtscheid* (1997); Schmidt, *Standort* (2004).

⁵⁸ Anonymus, [*Clermont*] *Freymüthige Betrachtungen* (1788); Macco, *Wespien* (1911); Schollen, *Wespin* (1911); Kley, *Geschichte* (1916); Heizmann, *Lage* (1923); Seidl, *Wollenindustrie* (1923); Hammer, *Betrachtungen* (1937); Kisch, *Deterrents* (1964); Kisch, *Textilgewerbe* (1981); Müller, *Studien* (1982); Müller, *Reichsstadt* (1992/93); Müller, *1798* (1998); Winzen, *Auseinandersetzungen* (1994).

⁵⁹ Schoeller, *Geschichte* (1894); Schoop, *Rechts- und Wirtschaftsgeschichte* (1920); Schulte-Krumpen, *Entwicklung* (1922); Schoop, *Geschichte* (1923); Fehr, *Geschichte* (1927).

⁶⁰ See the literature cited in Fn. 55-59; generally: Ebeling, *Handwerkswirtschaft* (1997); Ebeling, *Zunft Handwerk* (2000); Ebeling, *Möglichkeiten* (2001); Ebeling, *Entstehung* (2004). Important is also Pierre Lebrun's book on Verviers, Lebrun, *L'industrie* (1948); Barkhausen, *Verviers* (1960).

⁶¹ The regulations of the guilds are described in detail by Kley, *Geschichte* (1916), who underestimates the change in the course of the 18th century and overestimates the prevalence of traditional regulations that rather eroded slowly, see: Heizmann, *Lage* (1923); Winzen, *Auseinandersetzungen* (1994).

⁶² Kisch, *Textilgewerbe* (1981), 335. Ebeling argues, they had 'the function of the modern entrepreneur' Ebeling, *Möglichkeiten* (2001), 586, this will be discussed later.

⁶³ Krüger, *Geschichte* (1958), 509-10; Anonymus, [*Clermont*] *Freymüthige Betrachtungen* (1788), 23; see also Ebeling, *Möglichkeiten*

most of his wool in Spain (via merchants in Amsterdam who offered a credit line of more than 3 months)⁶⁴ and Silesia; smaller purchases were made in Saxony, Bohemia, or Moravia. He sorted, selected and scoured the wool because these operations determined the quality of the finished cloth and this decided about sales possibilities. The cloth-merchants sold their products on fairs and market places all over Europe and the Mediterranean World (e.g. Levant, Italian states, Russia, Northern Europe). They did not only have to finance the raw materials but also the distribution of the finished products whereby they had to concede credits up to 24 months in the international business.⁶⁵ The cloth-merchants in the gild-free woollen cloth industries of Eupen and Montjoie had similar functions; they were called *cooplydens*, *marchands*, *fabricateurs*, or *marchands fabricateurs*⁶⁶.

The production in Aix-la-Chapelle was organised as follows: The cloth-merchant handed the selected and scoured wool to the master-clothier, member of the weavers gild, who was only allowed to operate up to four looms. On behalf of the cloth-merchant and according to his needs (length, breadth, quality, finish of the cloth), the cloth-maker organised the whole process of production. First, the wool was spun by domestic workers against piece wage (either in the country or in the town).⁶⁷ The cloth-maker then prepared the loom bar and wove the cloth in his workshop; in order to fulfil the merchant's order he could employ further members of the weavers-gild whom he provided with yarn. The woven cloth was then dyed "in the piece" by an independent master-dyer, and it was fulled by an independent master-fuller (both received a piece wage); the fulled cloth was handed over to a master-dresser (shearer, cutter). All these artisans were organised by different gilds (e.g. the master-dresser was member of the tailors-gild⁶⁸). Finally, municipal and gild institutions (*Tuchsigel*, *Wollenambacht*) controlled the finished cloth in order to guarantee the quality of the local cloth production and the trademark (cloth of Aix-la-Chapelle).

The regulations of the guilds ensured standards of production to the cloth-merchants, the master-clothiers, and all the other artisans. This reduced transaction costs by saving efforts of control.⁶⁹ On the other hand, the regulations hindered and sometimes even prohibited larger quantities of production and, thereby, they prohibited the realisation of economies of scale. Pfister argues, with respect to gild regulations and the observable practice, that the guilds possessed a function similar to a firm because they had captured the control of the 'inner-industrial costs of transactions'⁷⁰. The definition of the firm used in this paper implies a different interpretation: In contrast to the organisation "firm", the gild regulations were formal rules (institutions) that had to be followed. Ignoring these rules was quite expensive.

The rules being compulsory for all producers defined precisely the qualities of the woollen cloths of Aix-la-Chapelle; they limited the employment of capital and labour. But within these limits the members of the different gilds could dispose rather independently. Thereby they still maintained their entrepreneurial function, what may be recognised by the vast freedom of contracting. However, in this system of production the master-artisans did not take any risk, while the cloth-merchant bore the commercial risk in the same way as the merchant in the putting-out system. On the one hand, the master-artisan, in particular the cloth-maker in relation to the cloth-merchant, provided some kind of "service"; and the "clothiers wage"

(2001), 593-94.

⁶⁴ Anonymus, *Feine Tuchmanufaktur* (1796), 35-36.

⁶⁵ See e.g. the diaries of two journeys to Russia in the second third of the 18th century, Stuhlmann/Scheins, *Geschäftsreisen* (1913).

⁶⁶ Anonym, *Eupener Tuchgewerbe* (2000), 139; Anonymus, *Feine Tuchmanufaktur* (1796).

⁶⁷ Anonymous report from 1781, quoted by Krüger, *Geschichte* (1958), 508.

⁶⁸ Kley, *Geschichte* (1916), 70; Ebeling, *Möglichkeiten* (2001), 590.

⁶⁹ The traditional regulations and the different institutions are described in detail by Kley, *Geschichte* (1916); Pfister, *Produktionsregimes* (2004), 165pp., emphasises the reduction of transaction costs.

⁷⁰ Pfister, *Produktionsregimes* (2004); similar Ebeling, *Handwerkswirtschaft* (1997), 327pp.

(*Tuchmacherlohn*) also points out to this perception. On the other hand, the clothiers were master-artisans working with own means of production employing journeymen and apprentices, and they were able to conclude a free contract. Nevertheless, the rules and regulations of the guilds bear a relevant potential of conflict. Again and again the large cloth-makers and also master-artisans tried to enlarge their control of production; and at the same time the erosion of the guilds endangered the position of the handicraft guilds, on which the business of the master-artisans was based on.⁷¹

In the 18th century the possible entrepreneurial profit was related to product quality. Thus, the cloth-merchants were almost engaged in high quality production. They purchased the wool mostly personally and they personally controlled its sorting and selecting. The second most important stage of production in order to achieve high quality products was careful and thorough finishing. The more successful cloth-merchants tried therefore to integrate wool preparation and finishing into own workshops. These manufactures that were mainly established in the first and second third of the 18th century in the gild-free towns of Burtscheid, Eupen, Montjoie, and Vaals included generally selecting, sorting, washing, and scouring of the wool and the dressing of the cloth (including shearing and pressing).⁷² Spinning and weaving remained domestic work on putting-out basis. Dyeing and fulling was done by separate “firms”, specialised master-artisans who owned the means of production and worked for different clothiers or merchant-manufacturers.⁷³ While dyeing required the knowledge of the master-dyer (who did not share his knowledge with other persons as long as he stayed in the business), fulling required a fulling mill that could not be simply erected because it depended on the licence to use the scarce resource of water.

The main reason of the cloth-merchants attempt to integrate dressing and shearing was controlling the work of the shearers because this was crucial for the quality of the product. This corresponds partly with Marglin’s hypothesis⁷⁴ of factory control that, however, aimed at explaining the emergence of the factory. Fine and superfine cloth required for high-valued tools (shears and cadres) and regular grinding of the shears. Both were quite expensive. In 1789 the shearing equipment in the Scheibler’s manufactures in Montjoie, Eupen, and Dolhain accounted for 25% of all fixed capital investments including buildings.⁷⁵ Though it cannot be proved, the cloth-merchants and the cloth-makers complained again and again that the artisan-dressers would not maintain their equipment and would therefore not work properly.⁷⁶ It seems that these artisans could either not afford the expenses or they increased profits by saving spendings. Some of them even bought second hand shears from producers of high-quality cloth.⁷⁷ Another reason for centralising the work were the high wages, as the dressers (shearers) received, due to the importance of their work and skill, higher earnings than any other artisan of the cloth industry apart from the dyer of cloth. The shearers were anxious to sell their labour as costly as possible and also were keen on controlling the scope

⁷¹ Concerning the resulting conflicts: Heizmann, *Lage* (1923), 14-15, 42-43; Seidl, *Wollenindustrie* (1923), 46-47; Kermann, *Manufakturen* (1972), 118-19; Winzen, *Auseinandersetzungen* (1994); Ebeling, *Handwerkswirtschaft* (1997), 327pp.; Pfister, *Produktionsregimes* (2004), 170-175; Anonymus, [*Clermont*] *Freymüthige Betrachtungen* (1788).

⁷² Seidl, *Wollenindustrie* (1923), 51-52, 60; Kermann, *Manufakturen* (1972), 121-22.

⁷³ See e.g. the description of cloth production in Burtscheid, Schmidt, Burtscheid (1997), 15-18.

⁷⁴ Marglin, *Bosses* (1976).

⁷⁵ Figures in: Barkhausen, *Tuchindustrie* (1925), 71.

⁷⁶ Memorandum of the cloth-makers corporation (*Feine Gewandschaft*) of Montjoie, 12.2.1790, cited in: Barkhausen, *Tuchindustrie* (1925), 113-117. Anonymus, *Feine Tuchmanufaktur* (1796); Anonymus, [*Clermont*] *Freymüthige Betrachtungen* (1788). Concerning conflicts with the dressers: Barkhausen, *Tuchindustrie* (1925); Hermanns, *Tuchscherer* (1982); Henkel, *Taglohn* (1989); Müller, *Reichsstadt* (1992/93).

⁷⁷ Memorandum of the cloth-makers corporation (“Feine Gewandschaft”) of Montjoie, 12.2.1790, Barkhausen, *Tuchindustrie* (1925), 114.

of their work.⁷⁸

To sum up, there are four reasons for the cloth-merchants to integrate dressing into their business: control of work and quality, reduction of wage expenses, reduction of capital requirements by employing economies of scale (purchase and maintenance of equipment), reduction of transportation costs, or, more generally, the reduction of transaction costs and the reduction of production costs. Therefore, the cloth-merchants of Aix-la-Chapelle established new workshops and manufactures near the town, especially in Burtscheid and Vaals, and also in the hinterland.⁷⁹ The cloth-makers of Düren were allowed to employ a limited number of shearmen in their workshops since 1713, but as the gild regulations could not be enforced this limitation was cancelled in 1744.⁸⁰ Developments like these diminished the significance of gild regulations for the production of woollen cloth. This interpretation is supported by existing conflicts within the tailors-gild when master dressers employed even up to 40 shearmen, though they were allowed to employ only four journeymen.⁸¹

The development in the gild-free towns (especially Eupen, Montjoie, Burtscheid, and Vaals) had been rather similar some decades earlier. The cloth-merchants also integrated, in addition to selecting, sorting, and scouring the wool, the finishing process (shearing, dressing, pressing) in own workshops and manufactures. Spinning and weaving was not integrated into the cloth-merchants own business until the end of the 18th century, when Scheibler in Montjoie established the first weaving manufacture.⁸² Generally, spinning and weaving, especially in Eupen, Montjoie, and Verviers remained the work of proto-industrial domestic workers (on putting-out basis) in the hinterland of the towns in order to reduce production costs. As the domestic workers usually owned at least a spinning wheel and many of them also a loom, this business did not afford any larger investment. They were provided with wool and oil by so-called “*baasen*”, middlemen who also incurred the yarn or the wool against piece wage. The proto-industrial producers did not visit the markets with their products; they rather offered a service to the cloth-merchant, who employed the work “laying fallow”. Though the precise relations of cloth-merchants, middlemen, and domestic workers are fairly unknown, it is assumed that the latter were dependent on single cloth-merchants because they could only spin or weave if they were provided with materials and if the middlemen collected the products. The domestic producers became similar to factory labourers, but they worked in their own houses without control, they employed own tools, and they owned a rural subsistence that allowed for selling the work cheaper than the journeymen in the workshop or in the manufacture.⁸³

The cloth-makers of Aix-la-Chapelle remained free artisans who worked on behalf of different cloth-merchants or other cloth-makers. They offered a “service” to the market by coordinating the spinning, the weaving, and the finish of cloth (while the importance of the last diminished); they were able to contract with different buyers (cloth-merchants). They may, therefore, be regarded as single “firms”. During the French occupation the system of putting-out cloth-merchants became pre-dominant in Aix-la-Chapelle, but it soon suffered competition from the implementation of the factory system.

⁷⁸ There are only few German data on wages and costs of production; see: Anonymus, *Feine Tuchmanufaktur* (1796), Appendix with some exemplary lists of costs of production.

⁷⁹ On resulting conflicts with the guilds: Heizmann, *Lage* (1923); Seidl, *Wollenindustrie* (1923); Winzen, *Auseinandersetzungen* (1994).

⁸⁰ Hammer, *Betrachtungen* (1937), 26; Fehr, *Geschichte* (1927).

⁸¹ Whether this workshop worked for a longer period is not clear: Schollen, *Wespin* (1911), 95; Heizmann, *Lage* (1923), 44-45; Seidl, *Wollenindustrie* (1923), 46, 52; Beckers, *Parteien* (1935); Kermann, *Manufakturen* (1972), 130; Winzen, *Auseinandersetzungen* (1994).

⁸² The Burgau manufacture (1793), Weingarten, *Tuchindustrie* (1922), 31; Barkhausen, *Tuchindustrie* (1925), 63, 48.

⁸³ Hammer, *Betrachtungen* (1937), 21; Dechesne, *L'industrie* (1926); Anonymus, *Feine Tuchmanufaktur* (1796); Anonymus, [*Clermont*] *Freymüthige Betrachtungen* (1788).

5. The implementation of machinery, the diffusion of mechanical production, and the emergence of the factory

It seems questionable whether the guild system in the Rhineland was as obstructive as the older literature on cloth manufacturing assumes.⁸⁴ At least in the second half of the 18th century the guilds of Aix-la-Chapelle could no longer enforce their regulations; in Düren they became meaningless. The industrial structure of cloth-merchant and artisan production under the guilds of Aix-la-Chapelle may even have favoured the transition to the factory. For instance, Ebeling argues that the artisans industrial training (apprenticeship, journeymen) lead to advantages in the case of transition to the factory.⁸⁵ There is also reason for the seemingly paradoxical assumption that in the beginning of the 19th the entrepreneurs of the formerly gilded town of Aix-la-Chapelle took the chance of modernising the industry more eagerly than the “modern” putting-out merchants that had established manufactures. Especially putting-out merchants, which had a long tradition, stuck to the proto-industrial (and manufacture) system of production. A representative of the government of Aix-la-Chapelle complained, for instance, in 1822 that the famous putting-out merchant *Scheibler, Ronstorff, Rahlenbeck & Comp.* (formerly *Johann Heinrich Scheibler*) did not invest in Montjoie but would divide it’s funds ‘*between our country and Belgium*’; the firm would produce on one side of the border or on the other and *Scheibler* would neglect his establishments in the Rhine-Province in order to increase profits by putting-out.⁸⁶

5.1 On machinery

In general, the transition to the factory of industrial capitalism was based on the consecutive mechanisation of different stages of production (*Figure 3*). The process took different courses in the Rhineland and in the West Riding, but nowhere did the transition to the factory cover all stages of production.

Figure 3: Stages of Innovation

	West Riding	West of the Rhineland
traditionally	Fulling mills	Fulling mills
1770s	S Spinning -Jenny	
1780s	F Gig mills S Scribbling and carding machines	
1790s	S Billys (slubbing machines) F Shearing frames	
1810s	F Gig mills F Shearing frames F Hydraulic pressing	S Spinning assortments consisting of Scribbling and carding machines, billy, jennies or mule-jennies F Gig mills F Shearing frames F Hydraulic pressing etc.
1820s	F Cylinder shearing machines F Fulling machines	F Cylinder shearing frames F Fulling machines
remark: the gig mill and the shearing frame was not often used in the West Riding before the 1810s, see below.		

Source: own construction

The first introduction of machines in the woollen cloth industry of the West Riding concerned spinning. Hargreaves spinning jenny was adapted to wool in the end of the 1770s. Small clothiers and even domestic spinners then bought little spinning jennies for their own purposes. The machines used at home had usually

⁸⁴ For a discussion of this literature, Ebeling, *Möglichkeiten* (2001), 588; also Müller, *Reichsstadt* (1992/93).

⁸⁵ Ebeling, *Entstehung* (2004).

⁸⁶ 'Hauptverzeichnis der vaterländischen Fabrikate [...] zur diesjährigen National-Ausstellung in Berlin [...]', Aix-la-Chapelle, 15.07.1822, Düsseldorf State Archives (DSTA), Reg. Aachen 7620.

less than 20 spindles⁸⁷ and they were driven by hand. The slubbings they processed to woollen yarn were still hand-spun. These spinning jennies increased productivity, but they did not change the production system, and neither the division of labour nor the scope of the firm changed dramatically.⁸⁸ Innovations of carding and scribbling played however a major role for the emergence of the factory. Scribbling and carding machines could not easily be integrated into the domestic system as the machines required an amount of moving power that could not be provided by workmen.

Spinning and scribbling and carding machines

The first rudimentary power driven scribbling machines appeared in the 1770s and 1780s,⁸⁹ but the scribbling mill was a development of the 1780s. The mills were established next to the fulling mills to utilise the power of the water wheels.⁹⁰ This solution resulted in an industrial division of labour that strongly affected the development of the regional woollen industry. The machinery of the scribbling mills consisted of the willy, the scribbler, the carder and the slubbing billy; but usually the mills did not process spinning machines or looms. The scribbling and carding mills were by far the largest group of the early factories, they numbered 220 in 1800.⁹¹ Many of the early factories of the West Riding integrated the preparation of wool, the production of slubbings, and the fulling of the woven cloth. Thus, they worked at two levels of production separated by the processes of spinning and weaving (and dyeing in case of “dyeing in the piece”). Of all the 60 mills that, according to Jenkins, processed broadcloth in the late 1790s, 50 were used also as a scribbling mill.⁹²

Therefore, a number of the West Riding’s clothiers invested into scribbling (and fulling) mills. These were too expensive for single smaller clothiers but *‘from the first introduction of machinery the clothiers united to build mills in shares’*⁹³. One reason may be that the scribbling mill like many fulling mills had primarily been a “public mill”. The small clothier brought his raw wool to the scribbling mill to card and slubb the wool; afterwards he gave the slubbing to his jenny spinners. When he had woven his cloth it was brought back to the mill to be scoured and fullled.⁹⁴ The owners (or the runners) of the scribbling mill, however, started to process their own wool instead of providing services. Thus, from the 1780s, groups of clothiers *‘amalgamated their capital and established mills to provide scribbling, carding and fulling services on a communal basis’*.⁹⁵ There were different types of such company mills (or union mills), companies of clothiers and cloth merchants, joint-stock companies of clothiers, and companies founded to rent mills that were erected by landowners or merchants.⁹⁶ Scribbling and fulling mills remained important until the second half of the 19th century. Even in 1834 about 50% of all woollen factories in the West Riding were scribbling and fulling mills.⁹⁷

The traditional system of woollen cloth production with domestic spinners and weavers, clothiers, master-fullers and master dyers, merchant clothiers, and so on was partly able to cope with this development. The

⁸⁷ Berg, *Age* (1985), 237.

⁸⁸ Hudson, *Genesis* (1986), 42.

⁸⁹ Jenkins, *West Riding* (1975), 22, 117.

⁹⁰ Jenkins, *West Riding* (1975), 117; Hudson, *Genesis* (1986), 33.

⁹¹ Jenkins, *West Riding* (1975), 75.

⁹² Jenkins, *West Riding* (1975), 8.

⁹³ Goodchild (Ossett Mill Company, 46-47), citation taken from: Hudson, *Genesis* (1986), 76.

⁹⁴ Crump/Ghorbal, *History* (1935), 69.

⁹⁵ Hudson, *Genesis* (1986), 35.

⁹⁶ Hudson, *Genesis* (1986), 77.

⁹⁷ Hudson, *Genesis* (1986), 52.

scribbling mill introduced a new marketable product, slubbings, which became the first marketable product of the woollen cloth industry apart from wool. This intermediate good was bought either by cloth-makers who employed domestic spinners, by independent clothiers who spun and wove the cloth themselves, or by self-employed spinners who sold their yarn to independent weavers. Yarn was the second and unfinished cloth was the third marketable product traded between the regional firms. In this manner the fulling and scribbling mills complemented rather than displaced the domestic system of production, and for several decades the proto-industrial structure functioned as a supplement to the emerging factories. Even in the 1850s the domestic industry provided about 50% of the workforce.⁹⁸

Pat Hudson recognises four ‘basic organisational units’ in the first half of the 19th century:

1. *The fulling and scribbling mill often owned by groups of small clothiers in shares.*
2. *The small domestic clothier, working on domestic premises or in a small workshop, making largely plain, undressed pieces and selling them in the local cloth hall.*
3. *the merchant manufacturer evolved from both the woollen merchant and the more substantial clothiers, undertaking dressing and, increasingly, also the scribbling, carding, fulling, spinning and weaving process in factory establishments.*
4. *The independent master cloth dresser working either on the commission for a merchant, or buying cloth from clothiers to finish and then sell to merchants.*⁹⁹

The West Riding housed thus two systems of production that both were based on mechanised production, (1) the system of domestic manufacture that meshed with the factory system¹⁰⁰ of separate firms running fulling and scribbling mills and with independent fulling mills or dyeing mills, and (2) the vertically integrated merchant manufacture. Since the eve of the 19th century the number of merchant manufacturers increased who integrated all stages of woollen cloth production into their firm and who established even very large companies employing some hundreds of workmen in their factory establishments. The famous works of Benjamin Gott & Company in Leeds were the most prominent example.¹⁰¹

In the region of Aix-la-Chapelle the process of transition followed a different line. Scribbling, carding and spinning was mechanised at the same time (*Figure 3*, above) and was soon integrated into factory establishments. The machines were bought as sets (*‘assortiment complet’*), of which one consisted of one willy, one scribbling machine, one carding machine, one billy with at least 40 spindles, and four jennies with 60-80 spindles each.¹⁰² This machinery was introduced by William Cockerill,¹⁰³ a mechanic from Lancashire who settled, after first employments in Russia and in Stockholm, in 1798 in Verviers less than 30km from Aix-la-Chapelle. His sons, John, James and William, entered his business and also John Hodson, who became his son-in-law. Since 1807 the Cockerills produced in Liège and established their famous iron works in Seraing.¹⁰⁴ Hodson separated his own business and concentrated on spinning machinery. Probably all the early spinning sets (produced before 1812) in the region of Aix-la-Chapelle were either produced by the

⁹⁸ Gregory, *Transformation* (1982), 69.

⁹⁹ Hudson, *Genesis* (1986), 36-37.

¹⁰⁰ Gregory, *Transformation* (1982), 218.

¹⁰¹ Crump, *Leeds* (1967 [1931]); Jenkins, *West Riding* (1975), 302pp. Appendix IV: Average fixed capital calculations.

¹⁰² *d'une machine à ouvrir la laine, coûtant 600 francs*
d'une machine [...] à drosser, coûtant 2.400 francs
d'une machine à carder, coûtant 2.400 francs
d'une moulin gros ou machine à filer en gros, coûtant 500 francs
de quatre machines à filer fin, coûtant 1.600 francs
faisant un total de: 7.500 francs'
 Details from Thomassin (1812), cited by Lebrun, *L'industrie* (1948), 242.

¹⁰³ On William Cockerill: Mahaim, *débuts* (1905); Kjellberg, *Ull* (1943), 517; Hodges, *Iron King* (1960); Hitch, Cockerill (1997).

¹⁰⁴ On James Cockerill and his Seraing works: Pasleau, *Cockerill* (1993).

Cockerills in Liège or by Hodson in Verviers, but then machine manufacturing workshops developed also in Aix-la-Chapelle and Eupen.

Due to the installation of complete spinning sets within factory establishments, home spinning in the west of the Rhineland was determined within only a few years. In the West Riding, domestic spinning remained part of the production system until the 1840s when the self-acting mules were established. Mechanisation in the Rhenish region was soon extended to raising and shearing and further stages of the finishing process. The result was the type of an integrated firm that, more or less, controlled the whole process of cloth production. Only dyeing was handed over to specialised artisans if the cloth manufacturer did not possess the specific knowledge of dyeing.

A comparison of the early scribbling and carding machines (*table 2*) demonstrates clearly that the machinery used by the clothiers in the region of Aix-la-Chapelle was, in general, coordinated and that it's extend was adjusted to the spinning capacities (or the spinning capacity was adjusted to the scribbling capacity).

Table 2: Early scribbling and carding machines, West Riding & region of Aix-la-Chapelle (incomplete), 1789-1819

West Riding			Aix-la-Chapelle								
		scribbling machines	carding machines			scribbling machines	carding machines	billies*	jennies*		
1789	Armley Mills	7		1809	J.H. Scheibler, Ron-storff, Rahlenbeck & Co.	Montjoie	3	3	3	12	
1793	Mill in Hunslet	6	1	1809	M.P.W. Troisdorff	Montjoie	4	4	4	16	
1794	Nether Mills	5		1809	Bernhard Scheibler	Montjoie	8	8	8	32	
1794	Castle Mill Gomersal		8	1809	Ignace van Houtem	Aix-la-Chapelle	5	5	5	20	
1796	Bean Ing		29	1809	Pranghe Hompt	Aix-la-Chapelle	5	5	5	20	
1799	Mill Bridge Mill	Liversedge	3 double engines	3 double engines	1809	Ph.H. Pastor	Burtscheid	4	4	4	16
1799	Mill at Farnley		6	1809	Edmund Jos. Kelleter	Aix-la-Chapelle	2	2	2	8	
1801	Mill at Holbeck		3	3	1809	Brass frères	Aix-la-Chapelle	2	2	2	8
1802	Mill Bridge	Bristall	2	5	1809	Fey frères	Aix-la-Chapelle	2	2	2	8
1804	Hebble Mill	Halifax	7	5	1816	Scheibler & Lenzmann	Montjoie	4	4	4	21
1809	Dudfleet Mill	Horbury	5	4	1816	Troistorff, M.L.W.	Montjoie	4	4	4	22
1790s	Messrs J. & J. Walker	Wortley		31	1819	H. von Fisenne	Aix-la-Chapelle	9	9	9	36

* some of the billies and jennies are estimated on the general information about "assortimente"

The west of the Rhineland knew three 'basic organisational units' in the first half of the 19th century:

1. The cloth factory of the cloth-manufacturer who evolved from both the putting-out merchants and the large clothiers, who undertakes the scribbling, carding, spinning, weaving, fulling, dressing process in factory establishments and sold his cloth all over the world.
2. The clothier who employed domestic spinners and weavers, paid fulling mills and master-dyers for their services, produced fine cloth and sold it to cloth merchants and at cloth fairs mainly in Germany.
3. The merchant clothier who did not integrate all stages of production and who employed domestic workers or other producers for the one or the other stage of production.

However, one dominating system can be distinguished that I call the "cloth factory system". These firms integrated vertically more or less all stages of production from scouring the wool to finishing and selling the cloth. Vertical integration of production into one firm does however not mean that each step of production was processed in a single establishment. For instance, as fulling the cloth required a lot of water the fulling mills were usually established at small rivers; and dyeing mills were usually outside of the towns because of water pollution.¹⁰⁵ Some of the "cloth factories" of Aix-la-Chapelle even possessed scribbling and fulling mills outside of the town, nevertheless, they integrated all stages of production into their

¹⁰⁵ The little town Montjoie was an exception because there were two different rivers that could be used.

“firm”. In case of weaving, power looms were not established until the 1840s; their number increased not remarkably before the 1860s. The specific reasons will be explained later, yet this late development is, from my point of view, no reason not to speak of a “cloth factory system”. Firstly, the process of spinning and the different processes of fulling and finishing the cloth were centralised into factory workshops, the work machines used were driven by water or power engines, and there was an extensive division of labour. And secondly, not weaving but finishing the cloth was the decisive stage of woollen cloth production. Weaving could easily be done outside of the factory yet most of the factory clothiers build large weaving establishments (manufactures) *and* they employed domestic workers on putting-out basis; this integration of workforce from outside of the factory establishments decreased the amount of fixed capital employed and allowed a rapid and cost-saving adjustment of capacities to increasing or decreasing markets.

Independent spinning factories were an exception from this rule and, it has to be remembered, they produced woollen yarn, but not slubbings; this yarn was sold to cloth factories or to small clothiers still existing. The spinning factories spun also wool of the clothiers against payment (*Lohnspinnerei*).

Finishing machines

The introduction of scribbling and carding machinery happened very early in the West Riding, but the diffusion of the gig mill (raising machine, *Figure 4*) and the shearing frame (*Figure 5*) was widely prohibited by social conflicts. The gig mill was used in some mills of the Huddersfield area in the 1780s and 1790s; however, in the beginning of the 19th century, its use and the use of the shearing frame, too, was largely prohibited by “luddits” who even pulled down some of the mills.¹⁰⁶

Figures 4: Gig mill, 1815

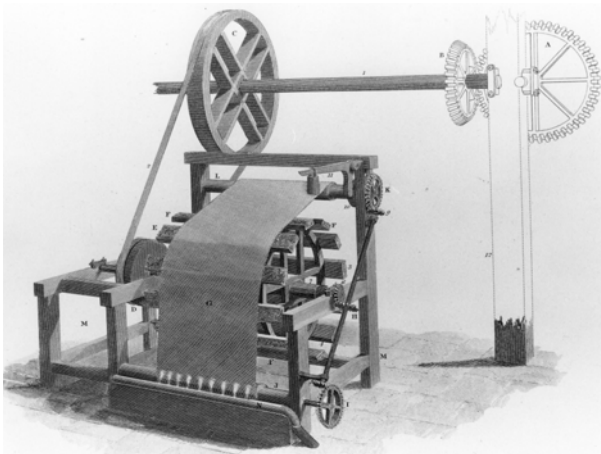
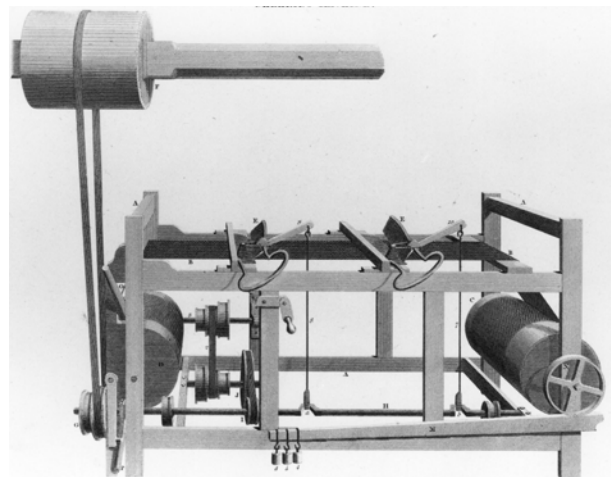


Figure 5: Shearing frame, 1811



Source Figures 4, 5: Rees Cyclopaedia, Plates, vol. IV (1820)

Jenkins assumes that the ‘*violent resistance of many of the workers perhaps prevented a more widespread use of the machines until at least the 1820s.*’¹⁰⁷ According to Lipson, who gives no prove, only five gig mills were in use in 1806, but the number increased to 72 in 1817.¹⁰⁸ At that time the gig mill and the shearing frame were already established in the west of the Rhineland. The first machines arrived at Aix-la-

¹⁰⁶ Lipson, *Woollen Industries* (1921), 188pp., Jenkins, *West Riding* (1975), 127-130.

¹⁰⁷ Jenkins, *West Riding* (1975), 128-29, citation 129.

¹⁰⁸ Lipson, *Woollen Industries* (1921), 191.

Chapelle and Montjoie before 1810.¹⁰⁹ There is however only one (seemingly) complete account of the gig mills of the cloth region for 1819 (*Table 3*). The total number of 152 suggests that at that time the use of the gig mill was more widespread in the Rhineland than in the West Riding. But the figure regarding Montjoie may be too high; a list of march 1817 names only two cloth manufacturers in the county (*Kreis*) of Montjoie who together possessed 17 gig mills.¹¹⁰ Nevertheless, the figures demonstrate that the gig mill had advanced to an important means of production. In 1819 two specialised machinery factories were established that produced spinning and finishing equipment, which employed only 28 workmen.¹¹¹

Table 3: Gig mills in the cloth region of Aix-la-Chapelle, 1819

	gig mills	construction firms
Aix-la-Chapelle	47	
Aix-la-Chapelle, county	3	
Düren, county	29	
Eupen, county	21	
Montjoie, county	52	
total	152	2

Source: *Gewerbetabelle von den einzelnen Städten und Kreisen des Regierungs-Bezirks Aachen für das Jahr 1819, DSTA Reg. Aachen BR 2116-43, F.207pp.*

There are no similar figures for the shearing machines, and because of the lack of precise information the diffusion of the shearing machines can only vaguely be evaluated. Lipton's figures about the increasing number of shearing machines in the West Riding (from 100 to 1.462 in 1817) are not proved.¹¹² This increase is hardly believable given the number of only 72 gig mills. In Aix-la-Chapelle the 'council of professionals' (*Rat der Werkverständigen*) registered 15 shearing frames within the town and five shearing frames in Burtscheid in 1816.¹¹³ There had been 24 additional machines in the county of Aix-la-Chapelle (*Landkreis Aachen*),¹¹⁴ and in Eupen 'shearing frames and gigmills [were] operated, partly by water, partly by steam and partly by horses'.¹¹⁵ There is not any information about the construction of these machines and one should be sceptical concerning the contemporary use of the term (e.g. in Montjoie the officials counted 70 shearing machines, but the number of workmen employed for operating the machines was too large, some of the 'machines' were probably shearing tables)¹¹⁶. The first rotation (cylinder) shearing machines of the type that was developed by Lewis and Price (rotary cutter)¹¹⁷ were introduced in the Rhineland in 1821/1822; French and American machines were simultaneously bought (*table 4*).¹¹⁸

¹⁰⁹ Nernich, *Tagebuch* (1809): 'Tuchscheren durch die Bewegung eines mit der Hand gedrehten Rades [...] zu Reims, Verviers, Aachen, Düren usw.' cited by Strauch, *Tuchindustrie* (1922), 33.

¹¹⁰ Appretur- und Stuhlarbeiten, 1.3.1817, DSTA Reg. Aachen BR 2116-13.

¹¹¹ One was the workshop of Xavier Kuetgens. Since 1812 he sold gig mills to the clothiers of Aix-la-Chapelle; he did receive an award from the French government for his innovation. According to the patent papers his first machine was driven by hand; City Archives Aix-la-Chapelle Akten betr. Handel u. Gewerbe 1813, N. 524. The source is destroyed but documented in: Ganser, *Wirkungen* (1922).

¹¹² Lipson, *Woollen Industries* (1921), 191.

¹¹³ Wichterich, *Entwicklung* (1922), 171-72.

¹¹⁴ General-Übersicht von dem Zustande der Fabriken, Manufakturen und der Gewerbs Industrie der Einwohner in dem Aachener Regierungs-Bezirk [...], 28.10.1816, DSTA Reg. Aachen 1567, F.73.

¹¹⁵ Bemerkungen über die im Kreise Eupen vorhandenen Fabriken, 1.10.1816, DSTA Reg. Aachen 1567, F.8.

¹¹⁶ Nachweisung der Fabriken und Industrie im Kreise Montjoie, 6.10.1816, Landrat Böcking, DSTA Reg. Aachen 1567, F.41.

¹¹⁷ Wachs, *Bedeutung* (1909), 62; Mann, *Textile* (1958), discusses the invention on pp.303-307.

¹¹⁸ The Prussian ministry of the interior promoted the diffusion of the machines; local industrialists received British and American machines as an award for outstanding products; DSTA Reg. Aachen 1636.

Table 4: Gig mills and shearing machines in single firms, proven evidence, cloth region of Aix-la-Chapelle, 1816-1830

name	city	year	gig mills	shearing frames	cylinder shearing machines
Offermann, Wilhelm & Krug	Imgenbroich	1816	1	8	
Scheibler & Lenzmann	Montjoie	1816/17	3	8	
J.H. Scheibler, Ronstorff, Rahlenbeck & Comp	Montjoie	1816 1822	2	8	x
Schmitz, P. & Söhne	Montjoie	1816 1822	1 1	8	
Math. P. W. Troistorff	Montjoie	1816	2	15	
different mills	Montjoie	1816	2		
different mills	Imgenbroich	1816	2	3	
Gebr. Schölller	Düren	1816 1822	x	x	x
Joh. Peter Schölller	Düren	[1830]	x	x	
Wagner & Sohn	Aix-la-Chapelle	1821 1828	x 4	x 28	2
Jos. Wilhelm Ibels & Comp.	Aix-la-Chapelle	1822 1829	8 ² 5		1
Edmund Jos. Kelleter	Aix-la-Chapelle	1822/27	5		x ³
Wilhelm Kuetgens & Söhne	Aix-la-Chapelle	1822	x	x	
Nikolaus Startz	Aix-la-Chapelle	1822 1825/30	x 22	x	x 12
Arnold Dedem	Aix-la-Chapelle	1825	x	x	
Gebr. Erckens	Burtscheid	1827	4	4	
Faulhaber & Sathois	Burtscheid	1827	2	4	
von Hoselt	Aix-la-Chapelle	1827	3		
van Gülpen & Kesselkaul	Aix-la-Chapelle	1828	5	2 *	
Hüffer & Morkramer	Eupen	1828	x	x *	
Carl Degive	Aix-la-Chapelle	1829	10	6	
J.M. Nellessen	Aix-la-Chapelle	1829	x	x	
And. Jos. Grand'Ry	Eupen	[1830]	x	x	
Joh. Homberg	Eupen	[1830]	x	x	
Ludwig Peil	Düren	[1830]	x	x	
Joh. Christ. Stollé	Eupen	[1830]	x	x	
² 5 driven by water, 3 driven by horses ³ American shearing machine * American type, rebuilt by Harkort machine works					

Sources: *Nachweisung der Fabriken und Industrie im Kreise Düren, Landrath von Lommessen, 31.10.1816, [...] im Kreise Montjoie, Landrath Böcking, 6.10.1816, DSTA Reg. Aachen 1567; List of finishing and weaving mills, Montjoie, 1.3.1817, DSTA Reg. Aachen BR 2116-43; Hauptverzeichnis der vaterländischen Fabrikate [...] zur diesjährigen National-Ausstellung in Berlin [...], Aix-la-Chapelle, 15.07.1822, DSTA, Reg. Aachen 7620; Namentliches Verzeichnis der Fabrikanten an welche [...] am] 7. Sept. 1827 die Aufforderung ergangen, über den gegenwärtigen Zustand der zu Aachen und Burtscheidt bestehenden Fabriken [...] Auskunft zu ertheilen, DSTA Reg. Aachen 1569; Ministerium des Innern, Beuth, to Reg. Aachen, 18.3.1830, DSTA Reg. Aachen 1636, F.101; Königl. Regierung, Abt. d. Innern, 29.5.1830, Prussian States Archive (PSTA) I. HA Rep. 120 A,V Fach 5 Nr.12, F.16-19; Korr, Einführung (1921), 62-79; Wichrich, Entwicklung (1922), 167 footnote 6; Dechêne, Entwicklung (1923), 24; Corsten, Wirtschaft (1925), 156, 170p.*

If the figures of *table 3* were true, there are two explanations. The introduction of the gig mill in the west of the Rhineland was, first of all, not burdened with as heavy social conflicts as in England, though there was also a remarkable opposition of the shearer in Eupen against new machines. Opposition resulted in a row in 1821 against a cylinder shearing machine that was introduced by the 'Gebr. Stollé'. The shearers were upset because of the rumour that this machine would process more than 1.300 meters of cloth each day.¹¹⁹

The second explanation is based on the structures of the two regional cloth industries. In the vertically integrated "cloth factory system" of the west of the Rhineland there were more incentives to introduce cloth finishing machines, because the cloth manufacturers could increase earnings by means of investments that

¹¹⁹ Bülow an Reg. Aachen, Berlin, 27.4.1821, DSTA Reg. Aachen 1636, F.7

resulted in decreasing internal production costs, whereas the master-dressers in the West Riding did not always own the necessary means to buy machines. In the first place, they were probably interested in high “wages”. The merchant manufacturers in the Riding had similar interests as the German cloth manufacturers and they were the driving force concerning the diffusion of the dressing machines in the English region.

Different product qualities could also explain the divergence in the case of the shearing frame. The first machines (*Figure 5*, above) did not allow to finish fine or superfine cloth; those were still sheared by hand. Even when the cylinder shearing machine had been introduced and various improvements had been made shearing by hand predominated the production of the highest qualities.¹²⁰ Therefore, it is not astonishing that e.g. the fine cloth manufacturer ‘*Wilhelm Ibels & Söhne*’¹²¹ of Aix-la-Chapelle introduced gig mills, but not shearing frames (see *Table 4*, above) until the extension of production in the end of the 1820s forced them to establish a rotary cutter. Yet meanwhile the regional industry (and the workmen) had gained some experience with the new machines.

Steam engines

Spinning and finishing machinery could only be efficiently exploited if power was sufficiently available. It has been mentioned that, at the first stage of industrial development, human power and horse power was employed to drive the machines, but particularly the large sets of machines could not be moved this way. They required powerful moving machines. The chosen moving force, however, steam machines, water wheels or, some years later, water turbines depended largely on the available resources (water and coal), on institutional arrangements (accession rights), and on the transportation system. Therefore, we can distinguish different patterns within the cloth district of Aix-la-Chapelle. Especially in the two towns of Aix-la-Chapelle and Düren and in the two counties (*Kreise*) of Aix-la-Chapelle and Düren the availability of water power was insufficient for the developing industry, and the possibility of employing water power was restricted: The accession rights were limited, the gradient of the narrow brooks was low and the amount of water small; there was competition with other branches that were dependent on water, too, like the paper industry of Düren, and the citizens of the towns were in need of drinkable water.

The steam engines provided a flexible power machine that did not depend on location factors as much as water wheels. They liberated production from climatic uncertainties, and they allowed a continuous utilisation of the capital and thereby an increase of production. For instance the first steam engine in the Rhenish region, established at Ph.H. Pastor in Burtscheid, was driven in case of water shortages and it was used by night;¹²² it was probably not allowed to operate a water wheel during the night. Since then the Rhenish cloth industrialists employed more and more steam engines, even if they owned water wheels and accession rights. However, the introduction of steam engines started 25 years later than in the West Riding, and its diffusion never reached a comparable degree. It is again difficult to compare the data for the two regions. A crucial problem is that in England most of the early steam engines were used to hoist water onto the water wheels rather than used as a moving power.¹²³ In Prussia the statisticians were only interested in moving steam engines. Jenkins counted 71 steam engines in the West Riding wool textile mills (including worsteds) that were introduced between 1790 and 1800.¹²⁴ If the majority of the early steam engines had been used as water hoisting machines, and if half of them had been used in the worsted industry, 20 steam

¹²⁰ See also: Jenkins, *West Riding* (1975), 130. See also Gregory, *Transformation* (1982), 132, on technical problems of the gig-mill and the shearing frames.

¹²¹ Ferber, *Beiträge* (1829), 146, 151.

¹²² Kunth, *Bericht 1816* (1888), 257.

¹²³ Jenkins, *West Riding* (1975), 85.

¹²⁴ Jenkins, *West Riding* (1975), 84, table 11.

engines may have been employed as moving power machines in the West Riding's woollen cloth industry in 1800. Their figure increased rapidly during the next years (*table 5*), though there is no information about the rate of water hoisting machines. *Table 5* and *table 6* demonstrate that the number of steam engines in the West Riding was much larger than in the west of the Rhineland.¹²⁵ It has been argued that the statistical accounts concerning the steam engines are not fully comparable, but the difference resulting from the water hoisting machines diminished in the course of the years. According to the data for 1837 and 1838 the number of steam engines was more than 7 times higher in the West Riding than in the Rhineland. The tables demonstrate further that the development was dynamic and the number of machines in the Rhineland grew during the 1830s (1830-1852) with a yearly rate of 8% (7%); it started off, however, from a low level.

Table 5: Water and steam engines in the woollen cloth industry, West Riding, 1835, 1838

h.p. per engine	1835						1838	
	Jenkins		Gregory		Jenkins		Gregory	
	Water power			Steam power			Water	Steam
	total h.p.	no. of wheels		total h.p.	no. of engines		no. of engines	
50+	210	4	4	280	4	4	1	13
49-40	160	4	4	683	17	17	2	21
30-30	125	4	4	1527	48	48	7	74
29-20	306	14	14	1815	80	80	27	87
19-10	1242	101	101	1677	125	131	91	138
<10	629	114	110	236	34	36	108	40
Totals	2672	241	237	6218	308	316	236	373
average h.p.		11,1	11,3		20,2	19,7		
growth rate, yearly								5,7%

Sources: Jenkins, *West Riding* (1975), table 9, p.77, table 12, p.94; Jenkins/Ponting, *British Wool* (1987), table 6 (based on *Factory Returns 1835*); Gregory, *Transformation* (1982), table 5.4, p.202 (based on *Parliamentary Papers 1836, XLV, Parliamentary Papers 1839, XLII [=Return of all the mills]*)

Table 6: Steam engines in the woollen cloth industry, Regierungsbezirk Aix-la-Chapelle, 1830-1852

	1830		1837		1840		1852	
	steam engines	h.p.	steam engines	h.p.	steam engines	h.p.	steam engines	h.p.
Aix-la-Chapelle	14	219	18	289	19	320	33	666
Aix-la-Chapelle, district	6	36	10	94	11	122	14	148
Düren, district	4	51	9	113	9	111	10	128
Eupen, district	6	49	14	145	14	145	20	349
Montjoie, district	1	8	2	14	2	14	1	8
total	31	363	53	655	55	712	78	1299
average h.p.		11,7		12,4		12,9		16,7
growth rate, yearly 1830-1837			8,8%					
growth rate, yearly 1830-1840					7,0%			
growth rate, yearly 1830-1852							6,0%	
figures for 1843, 1846, 1849 incomplete								

Sources: Königl. Reg. Abt. des Innern, Aachen, 29. Mai 1830, PSTA, I. HA Rep. 120 A, V Fach 5 Nr. 12, F.16-19; Korr, *Einführung* (1921), 44pp., 54pp., 62p., 69-79, 82. *Anhänge zu den Gewerbe-Tabellen der Kreise des Regierungs-Bezirks Aachen pro 1837 [... 1840, 1843]*, in: DSTA BR 2116-46 u. BR 2116-47. *Nachweisung derjenigen Fabrikationszweige, welche zusammen eine Anstalt bilden, in der Gewerbe-Tabelle der Fabrikations-Anstalten [...] für das Jahr 1852 aber in verschiedenen Kolumnen vertheilt sind*, in: DSTA BR 2116-54, F.71pp., BR 2116-50, F.467pp., F.477pp., F.486pp., F.491p., BR 2116-49, F.169p.

¹²⁵ It must be mentioned that corresponding to all the data on the west of the Rhineland the data set is not complete and some information are contradictory (a more detailed list for 1830 is given in table 7, below); as it is impossible to verify the information it is necessary to reason according to plausibility.

In the West Riding there was a remarkable increase of machinery (18%), the period considered was however very short and the development may be biased. The published data for the following years provide only information on total horse power and horse power employed per mill, but this does not tell us how many steam engines were used.¹²⁶ Of course, an increase of horse power allowed supplying a larger number of machinery, but it depended (1) on the scale of the factory how much power should be employed, and (2) it depended on the efficiency of the transmission system how much power was needed to move the machines. The data for the west of the Rhineland show that the average power of the machines increased slowly but permanently; new machines were in general much more powerful than the older ones. Yet the horse power per machine was 50% larger in the English region than in the German region in 1837/38. Even in 1852 the Rhenish factories did not reach the English level of 1835. One possible explanation is that most of the steam engines in the West Riding were used in scribbling and fulling mills, which required a lot of moving power, while the machines in the west of the Rhineland were more often employed for spinning, raising and shearing (see *table 7*) whereas most of the power for the fulling mills stemmed from water wheels and water turbines (in Eupen since the 1840s).

It has to be mentioned that the woollen cloth industry of the west of the Rhineland was pioneering the implementation of the steam engine into factory production in Germany. *Table 7* does not only provide more detailed information about the different steam engines, it shows also that the regional woollen cloth industry housed about 40% of all the steam engines of the Prussian textile industries and that these amounted to more than 13% of all steam engines in use. In fact, these figures demonstrate also the backwardness of the Prussian industry.¹²⁷

The introduction of new machinery increased labour productivity and it reduced production costs. Both are difficult to estimate because of insufficient information. But Lipson and Gregory provide data on the duration of cloth production and the cost of labour based on the Parliamentary papers. The figures of Lipson who was concerned with the two periods of 1781-1796 and 1796-1805 are supplemented by Gregory for the whole period of the introduction of spinning, scribbling, carding, and finishing machines until 1828 (*table 8*).

The finding demonstrates an increase of labour productivity by more than 50% due to the implementation of machines for spinning, for scribbling and carding and because of the implementation of the gig mill. The rotation shearing machine reduced the time required for shearing by 80%, but this reduced total working time by only 10%. The development of production costs was similar; however, they decreased only by 30% (1780-1805) due to rising wages for the qualified workers. Even if these figures do only illuminate the tendency of the process, the productivity gains were obviously relevant.

There is no doubt that this tendency applies also to the Rhenish development. And the information concerning the west of the Rhineland confirms the estimates of *table 8*. In 1809 William Cockerill praised that his spinning sets required only '*11 people, men and children, using the machines*'. These workers could '*do more work than 100 people spinning by hand*'. Expenses for wages were also reduced by 85% (from 540£ to 75£ 12s weekly).¹²⁸

¹²⁶ See: Mann, *Cloth* (1971), 220, for data on 1850-1867

¹²⁷ This evaluation also holds true for the other German states.

¹²⁸ Cockerill to prefect of the Departement Ourte, 9.5.1809, Gobert, *Conditions* (1911), 180pp.. Translated by Hitch, Cockerill (1997), 22pp. Information on the factory of E. Kelleter indicates also a productivity increase of 90%, Kraus, Weg (1994), 219.

Table 7: Steam engines in the woollen cloth factories, cloth region Aix-la-Chapelle, 1830

	registration	pressure		h.p.	use of the machine, as mentioned
		high	low		
Aix-la-Chapelle, town					
E. J. Kelleter	1817		1	16	cloth factory
E. J. Kelleter	1821/22		1	20	cloth factory and heating
Wagner & Sohn	1822		1	18	gig mills and shearing machines
Gotthard Startz	1822		1	15	spinning sets, fulling mill, gig mills, shearing machines
Gotthard Startz	1830	1		20	spinning sets, fulling mill, gig mills, shearing machines
Arnold Dedem	1825		1	18	gig mills and shearing machines
Regnier Poncelet & Desoer, Shearing mills & mechanic works	1825		1	8	gig mills
J.M. Nellessen*	1826*			x* 12	
J.M. Nellessen	1828	1		20	cloth factory
J.M. Nellessen	1829			18	spinning sets, washing machines, fulling mill, gig mills, shearing machines
Jos. Math. v. Hoselt	1827		1	10	spinning sets, gig mills, shearing machines
Carl Degive	1829	1		16	spinning sets, washing machines, fulling mill, gig mills, shearing machines
Wwe. Hartogs & Comp.	1830		1	8	cloth factory
Jos. Wilh. Ibels			1	10	gig mills and shearing machines
Geschwister Lennartz			1	10	gig mills and shearing machines
van Gülpen & Kesselkaul	1827		1	12	spinning sets, gig mills, shearing machines
Wittwe Collins*	1830			x* 24	
Ignaz van Houten*	1830			x* 24	
total	14	3	11	219	
Aix-la-Chapelle, county district					
Wwe. Conrad Pastor, Burtscheid			1	4	woollen yarn spinning
Wwe. Erkens, Burtscheid		1		4	woollen yarn spinning, shearing machines
Wwe. Wilh. Pastor, Burtscheid			1	4	woollen yarn spinning
Jos. Ruland, Burtscheid		1		12	woollen yarn spinning
von Guaita Erben, Laurensberg		1		7	woollen yarn spinning
Offermann & Söhne, Stolberg			1	5	woollen yarn spinning
total	6	3	3	36	
Düren, district					
Schöller Söhne, Düren			1	8	cloth factory, only during water shortages
Ludwig Peil, Birkesdorf		1		18	spinning sets, gig mills, shearing machines
Joh. Peter Schöller, Schönwald			1	10	woollen yarn spinning, shearing machines
Joh. Peter Schöller, Wiesenau			1	15	fulling mill and gig mill
total	4	1	3	51	
Eupen, district					
And. Jos. Grand'Ry, Langerthal			1	10	spinning sets, gig mills, shearing machines
Joh. Homberg			1	3	gig mills and shearing machines
Hüffer & Morkramer, Oede			1	10	gig mills and shearing machines
Bernh. Georg von Scheibler			1	10	woollen yarn spinning
Gustav von Scheibler			1	6	woollen yarn spinning
Joh. Christ. Stollé			1	10	spinning sets, gig mills, shearing machines
total	6		6	49	
Montjoie, district					
Voell & Comp., Imgenbroich			1	8	gig mills and shearing machines
total	1		1	8	
Regierungsbezirk					
Aix-la-Chapelle	31	8	23	362	woollen cloth industry
	2	1	1	12	needle works and machine manufacturing
	28	8	20	735	coal mines and water boosting
total	61	17	44	1109	
* = these machines are not mentioned in the official account but they are mentioned by Korr and others.					
<i>Prussia</i>	79				<i>textile industries</i>
	231			3670	

Sources: Königl. Reg. Abt. des Innern, Aachen, 29. Mai 1830, PSTA, I. HA Rep. 120 A, V Fach 5 Nr. 12, F.16-19; Korr, Einführung (1921), 44pp., 54pp., 62-63, 69-79, 82.

Table 8: The time required by an individual to make a piece of superfine broadcloth and the cost of labour

Gregory's summation of the working minutes is corrected.

The time required by an individual to make a piece of superfine broadcloth and the cost of labour

	Nature of employment		Quantity		Persons employed			Time						Cost for a Piece					
	1781-1796	1796-1805	1781-1796	1796-1805	1781-1796	1796-1805		1781-1796	1796-1805	saving	1805-1820	saving	1820-1827	saving	1828	saving	1781-1796	1796-1805	saving
			lbs.	lbs.	m man, f woman, ch	m man, f woman, ch		min.	min.		min.		min.		min.		s.	s.	
1	Cleansing the wool	Cleansing the wool	80	80	1 m	1 m		202	202		202		202		202		0,75	0,75	
2	Picking	Picking	80	80	1 f	1 f		6.062	6.062		6.062		6.062		6.062		8,44	10,19	-21%
3a	Scribbling by hand	Scribbling by machine	75	75	1 m	1 ch		5.760	840	85%	840		840		840		11,67	0,58	95%
3b		Carding by machine		75		1 ch			801		801		801		801			0,58	-100%
3c		Slubbing by machine		25		1 m 2 ch			424		424		424		424			2,60	-100%
								5.760	2.065	64%							11,67	3,77	68%
								5.762	2.065	64%	2.065		2.065		2.065				
4	Spinning warp	Spinning warp	26	25	1 f 1 ch	1 f		15.600	2.297	85%	2.297		2.297		720	69%	32,50	11,08	66%
5	Spinning abb	Spinning abb	44	50	1 f 2 ch	1 m 2 ch		21.120	2.057	90%	2.057		2.057		0	100%	29,33	11,46	61%
6	Spooling warp	Spooling by machine	26	50	1 f, old	1 ch		3.120	1.440	54%							2,17	0,50	77%
								2.100	1.440	31%	1.440		1.440		1.440				
7	Warping	Warping round bar	26	25	1 f	1 f		720	720								0,71	1,52	-115%
								720	600	17%	600		600		600				
8	Reeling abb	Reeling abb	44	25	1 ch	1 f		720	600	17%							0,50	0,71	-42%
								720	720		720		720		0	100%			
9	Weaving	Weaving by spring shuttle	1 piece, 34 ells	1 piece, 34 ells	2 m 1 ch	1 m 1 ch		21.840	15.120	31%	15.120		15.120		15.120		55,50	51,50	7%
10	Scouring	Scouring	"	"	1 m 1 boy	1 m 1 boy		180	180		180		180		180		0,50	0,50	
11	Burling	Burling	"	"	1 f	1 f		1.920	1.920		1.920		1.920		1.920		3,00	3,00	
12	Felting	Felting	"	"	1 m 1 boy	1 m 1 boy		600	720	-20%	720		720		720		8,00	8,00	
13	Raising the nap	Raising the nap	"	"	1 m	1 m 1 boy		5.280	720	86%	720		720		720		14,17	3,67	74%
14	Shearing	Shearing	"	"	1 m	1 m		4.320	5.280	-22%	1.080	80%	360	67%	360		10,00	14,75	-48%
15	Pressing and finishing	Pressing and finishing	"	"	1 m	1 m		120	120		120		120		120		1,00	1,00	
	total ref. Lipson							87.564	39.503	55%							178,23	123,42	31%
	total ref. Gregory in hours							1.442	1.020	29%	966	5%	954	1%	770	19%			
	total ref. Gregory in minutes							86.520	61.200	29%	57.960	5%	57.240	1%	46.620	19%			
	corrected calculation in minutes							86.546	39.301	55%	35.303	10%	34.583	2%	30.229	13%			

(A) From 1781 to 1796.

(B) From 1796 to 1805. Machinery was introduced in the period for scribbling, carding, and spinning. The fly shuttle also came into use.

1781-1796. Note. - The weaver, out of his earnings, had to pay house-rent, and all the expenses of the wear and rear of loom and tackle

Sources: Lipson, *Woollen Industries (1921)*, 258-59; Lipson refers to *Parliamentary papers, 1840, vol. xxiii, 439pp.* Gregory, *Transformation (1982)*, 90. Table 3.1: Labour time in the production of superfine broadcloth (1781-96, 1796-1805, 1805-20, 1820-27, 1828)

Power-loom weaving

This chapter on machinery closes with some remarks on power-loom weaving. Similar to spinning short fibred wool on the mule, it was difficult to adapt the power-loom to woollen yarn weaving (since 1822).¹²⁹ Again precise figures are not available. There is evidence of 1.000 power looms in the West Riding in 1835, but it is unknown if they were used for the purpose of mechanical weaving; many of the power-looms probably have been “dandy-looms” (von Tunzelmann) that used power only for winding on the cloth beam. But the other British cloth districts had much less power looms; e.g. the fine cloth district of Gloucestershire ran only 101 in 1838.¹³⁰

Based on the different use of power looms, Gregory argues that the West Riding ‘*was technologically more advanced than its rivals elsewhere*’.¹³¹ But the implementation of machinery is rather a matter of economic choice than a matter of modernism. And it seems that the mechanisation of fine-cloth weaving was hindered by technical and economical disadvantages. Until the 1840s the power-loom, ‘*went at no greater pace than the hand loom. Hence the best pieces [...] were woven much better and equally quicker by the hand-loom.*’¹³² Von Tunzelmann also summarises that power-looms were ‘*less economical (or technically efficient) in coping with higher quality of cloth*’; the incentives to mechanise weaving were ‘*exceptionally weak*’.¹³³

This observation holds also true for the implementation of the power loom in the Rhenish cloth district. In the beginning of the 1840s single copies of the first looms were installed; and it seems that at first the industrialists wanted to try out whether the machines were of any use to them and whether they could be integrated into their production scheme. The *tables of manufacturers* (they are analysed in the following chapter) counted only 33 power-looms in the whole Rhenish woollen cloth district; it rose to 380 in 1858.¹³⁴ Only few industrialists opted for power weaving with two of them equipping their factories with a “large” number of power looms (*J.H. Nellesen*, 85, and *Carl Waldhausen*, 53).¹³⁵ Certainly, at that time there were 6.275 power-looms in the woollen cloth industry of Yorkshire (35.398 for worsteds).¹³⁶ Compared to the British development the diffusion of power-loom weaving in the Rhenish district was only beginning. There was, however, a whole set of reasons: the technical problem of adapting the loom to fine-cloth weaving were still unsolved; productivity gains¹³⁷ were small, if there were any at all concerning fine broadcloth; wage expenses did probably increase (because of the higher qualification of the weavers); investment costs were high. Therefore, the decision of Rhenish cloth producers not to invest newly in high fixed costs may even be regarded as rational: the incentives for new investments were really very weak.

¹²⁹ Inventions by Richard Roberts and improved construction by Josua Heilmann (Alsace, 1823), Wachs, Bedeutung (1909), 54; see also: von Tunzelmann, *Power* (1978), 245.

¹³⁰ Figures: Gregory, *Transformation* (1982), 66.

¹³¹ Gregory, *Transformation* (1982), 66.

¹³² Heaton, Yorkshire (1965), 357, he continues that the machine were scarcely known ‘*until about 1832, and made very little progress during the next twenty years.*’

¹³³ von Tunzelmann, *Power* (1978), 245.

¹³⁴ Gewerbe-Tabelle der Fabrikations-Anstalten und Fabrik-Unternehmungen aller Art des Regierungs-Bezirks Aachen für das Jahr 1846 [1849, 1852, 1855, 1858], in: DSTA BR 2116-48, BR 2116-49, BR 2116-54, BR 2116-55.

¹³⁵ Spezielle Nachweisung der in der Gewerbe-Tabelle der Fabrikations-Anstalten und Fabrik-Unternehmungen aller Art des [Regierungs-Bezirks Aachen] für das Jahr 1858 angegebenen Fabriken und Anstalten, welche jede mehr als 50 Arbeiter beschäftigt, in: DSTA BR 2116-53.

¹³⁶ Figure for 1856, von Tunzelmann, *Power* (1978), 245.

¹³⁷ See also: Schmoller, *Geschichte* (1870), 496.

A recapitulating comparison of the implementation of machinery that has been analysed in this chapter allows the conclusion that the industrialists' attitude towards the power-loom was not based on technological backwardness or risk averseness. In spite of that, the implementation of machinery was a question of economic choice. In the beginning of the 19th century the Rhenish cloth industrialists had rapidly introduced the gig-mill, and they had slowly adopted the shearing machine. It seems as if the industrialists were prepared to modernise production by new investments if these paid themselves off and if the new machines were useful with respect to the production of fine-cloth.

5.2 Workforce and the scope of the factory

Comparing the early factories of different regions in different states is a difficult task that even increases if one gets into details. One problem is the quality of contemporary and published information. Regarding the West Riding, and the United Kingdom, there is a large amount of aggregate information concerning production, workforce, and number of firms as well as employment of water or steam engines provided by the Parliamentary commissions that did inquiries since the beginning of the 19th century. There is also information that stemmed from fire insurance policies. Jenkins has made this information available.¹³⁸ In 1850 the West Riding of Yorkshire saw about 40.000 working people in the woollen cloth industry who worked in 880 mills (*table 9*); this region alone covered about 2/3 of the mill workers of the whole English woollen cloth industry. Unfortunately there is only insufficient information about the domestic workforce, but according to the indication given by Pat Hudson¹³⁹ its number may have been nearly the same as the workforce of the mills.

Table 9: Woollen mills & workers in West Riding, Yorkshire, 1835-50

A. Number of Employees in Woollen Mills, 1833 West Riding			Totals of 1835 West Riding		B. Number of persons employed in manufacturing establishments, 1851, Yorkshire			Totals of 1850 West Riding	
Employees	Woollen mills		mills	workers	Employees	Woollen cloth manufacture	mills	workers	
<25	28	19,7%			1-9	304	52,3%		
25-49	46	32,4%			10-49	224	38,6%		
50-74	31	21,8%							
75-99	10	7,0%							
100-49	10	7,0%							
150-99	8	5,6%			50-199	40	6,9%		
200-99	5	3,5%			>200	13	2,2%		
300-99		0,0%							
>400	4	2,8%							
	142	100,0%	406	23.636		581	100,0%	880	40.611
			av.	58,2				av.	46,1

Sources: *A. Jenkins, West Riding (1975), 69, Table 8: Number of Employees in Woollen and Worsted Mills Recorded by Children's Employment Commissioners in 1833. B. Hudson, Genesis (1986), 41, Table 2.2.; Number of persons employed in manufacturing establishments for which 'masters' sent in returns to 1851 census: Yorkshire. Totals: Gregory, Transformation (1982), 61, Table 2.11 and 63, Table 2.12.*

The number of working people in the regional cloth industry of Aix-la-Chapelle was probably only half as large as the workforce of the West Riding's industry (*table 10*). But the Rhenish figures included, according to the Prussian *tables of manufacturers*, any establishment that employed machinery and/or any establishment that covered more than one stage of production. Therefore, a comparison of the English and Prussian data provides only a vague clue concerning the direction of the development.

¹³⁸ Jenkins, *West Riding* (1975).

¹³⁹ Hudson, *Genesis* (1986), 41.

Table 10: Woollen cloth manufacturing establishments and workers, administrative district of Aix-la-Chapelle (Regierungsbezirk) and Prussia, 1846-1858

	1846	1849	1852	1855	1858	1861
Prussia						
workers, yarn producing	15.927	15.052	16.141	15.365	14.487	14.074
workers, cloth producing	30.206	29.888				26.078
total of workers	46.133	44.940				40.152
District of Aix-la-Chapelle						
Spinning establishments	71	64	70	71	94	107
spindles	92.718	94.909	120.744	113.755	156.768	
workers	3.100	3.182	3.496	3.137	3.474	3.285
cloth factories	135	133	127	118	119	103
workers	18.733	17.910	17.454	10.930	12.514	12.533
power looms	33	28	136	207	380	
hand looms	5.075	5.394	5.360	4.015	4.741	
note: most spinning factories belong to a cloth factory						
total of wool manufacturing workers	21.833	21.092	20.950	14.067	15.988	
workers in factory establishments based on "factory lists"		13.921*	16.004	15.008	16.784	
		*not completed				

* Factory establishments: establishments > 10 employees; 1858 > 50 employees

Sources: *Gewerbe-Tabelle der Fabrikations-Anstalten und Fabrik-Unternehmungen aller Art des Regierungs-Bezirks Aachen für das Jahr 1846 [1849, 1852, 1855, 1858], in: DSTA BR 2116-48, BR 2116-49, BR 2116-54, BR 2116-55; Anhänge zu den Gewerbe-Tabellen der Kreise des Regierungs-Bezirks Aachen pro 1846 enthaltend Dampfmaschinen, Maschinenspinnereien und Fabrik-Anstalten, in: DSTA BR 2116-47; Anhänge zur Gewerbetabelle des Landkreises Aachen pro 1846, in: DSTA BR 2116-47; Nachweisung derjenigen Fabrikationszweige, welche zusammen eine Anstalt bilden, in der Gewerbe-Tabelle [...] für das Jahr 1849 [1852, 1855], aber in verschiedenen Kolumnen vertheilt sind, in: DSTA BR 2116-49, BR 2116-50, BR 2116-54; Verzeichnis derjenigen Fabriken, welche außer dem Hauptorte der Fabrik auch an anderen Orten Arbeiter beschäftigen [1852], in: DSTA BR 2116-54; Nachweisung derjenigen Fabriken von Gewerben, welche am Wohnsitz des Inhabers und ausserhalb desselben Arbeiter und Webstühle beschäftigen [undatiert für 1855], in: DSTA BR 2116-54; Spezielle Nachweisung der in der Gewerbe-Tabelle der Fabrikations-Anstalten und Fabrik-Unternehmungen aller Art des [Regierungs-Bezirks Aachen] für das Jahr 1858 angegebenen Fabriken und Anstalten, welche jede mehr als 50 Arbeiter beschäftigt, in: DSTA BR 2116-53; Tabellen und amtliche Nachrichten über den Preussischen Staat für das Jahr 1849, Bd. VI (Tabelle der Fabrikations-Anstalten und Fabrik-Unternehmungen aller Art für 1849 und 1852), Statistisches Bureau zu Berlin, Berlin 1855, 886pp., 1225pp.; Ergebnisse der Volkszählung und Volksbeschreibung nach den Aufnahmen vom 3. Dezember 1861 (1864)*

The Prussian statisticians at that time collected (1) data on the total employment of the woollen industry (*table of manufacturers*), and (2) appendixes to the *table of manufacturers* providing information on single firms concerning spinning machines, looms, power and water engines, workmen etc. (in the following *factory lists*). These appendixes are far from being complete; and the use of both types of data is not unproblematic, because they are either based on the knowledge of the burgomaster (mayor) and the chief director of police, who were responsible for collecting the data on the local level, or they are based on entrepreneurial information. Some entrepreneurs gave e.g. recent number of workmen, others gave the number of “ordinarily employed persons”. The main problem of data collecting was that administration was not authorised to enter factory establishments and many entrepreneurs were opposed to present any information because they feared higher taxation. Data collection was complicated by the high volatility of employment. The number of employees changed from month to month and even from day to day, but the lists were not based on an effective day.¹⁴⁰ Because of all these problems, the president of the local industrial curt (*Gewerbegericht*) disappointedly stated that *‘the inspection of the factories had proved to be infeasible.’*¹⁴¹ Six months later, in May 1853, the disaffected county administrator and chief director of po-

¹⁴⁰ Even if the administration had been authorised to enter the factories, collecting the complete information had been difficult e.g. with respect to data on weavers working at home with own looms or with looms possessed by the entrepreneur.

¹⁴¹ President of the industrial curt (Strom) to county administrator and chief police director Haßlacher, 22.11.1852, DSTA BR 2116-50, F.497.

lice, who then had to collect the data himself, still wrote that he ‘often received unsatisfactory or even not any information’ from the entrepreneurs. He calculated the missing data on workforce, but in spite of the striking difference of more than 30%, he regarded his figures as more reliable than the information he had ‘*wrung from the entrepreneurs*’.¹⁴²

The resulting figures are not only incomplete; they are rather contradictory to some degree. For another purpose, I constructed a set of data from the more detailed *factory lists* reduced to establishments with more than 10 employees (more than 50 for 1858). The total number of the “factory” workforce thus obtained is shown in *table 10* (workers in factory establishments). The number of employees provided by the *factory lists* should be lower than the figures of the *tables of manufacturers*. Surprisingly, this is not the case for 1855 and 1858. There may be reasonable explanations as e.g. the inclusion or exclusion of domestic workers or sideline occupation, yet the necessary information concerning the direction of the bias is not available and the differences cannot be eliminated. However, the intention of this “excursus” is not complaining missing data; it should qualify the arguments based on factory employment.

The published information on the West Riding is, in general enormous, and it is, in spite of some contradictions, more or less reliable. Employing the data for a comparative purpose needs however further information, especially concerning the definition of what exactly was counted, but the literature is not always clear if e.g. mills (factories) or firms were counted. Generally the number of mills should be larger than the number of firms as one or the other firm did own more than one mill, this is however not the case.¹⁴³ Another example is the striking difference between the figures provided by Jenkins and Hudson (*table 9* above). Jenkins concedes that his list is biased towards larger mills,¹⁴⁴ and Hudson’s list is biased towards small firms.¹⁴⁵ However, evidently the small mill dominated in the West Riding cloth industry in the first half of the 19th century. This applies to the Rhenish cloth district, too. According to Jenkins’ account (biased towards larger establishments), 50% of the workforce of the West Riding was employed in mills with more than 50 workers. Apart from these figures there are no published data concerning the size range of the factories. Jenkins/Ponting and Julia de Lacy Mann (*table 11*) include only total figures of mills and employees of the woollen cloth manufacture.

Table 11: Mills and employees of the English woollen cloth industry, 1835-1867

	mills			employees, 1000			employees per mill		
	England & Wales	Yorkshire (West Riding)	West of England**	England & Wales	Yorkshire (West Riding)	West of England**	England & Wales	Yorkshire (West Riding)	West of England**
1835	995	406	205	47,8	23,6	12,6	48,0	58,1	61,5
1850	1306	880	147	64,4	40,6	11,1	49,3	46,1	75,5
1856	1282	806	115	69,1	43,0	10,0	53,9	53,3	87,0
1861	1456	924	107	76,3	50,5	10,1	52,4	54,7	94,4
1867	1420	818	116	105,1	62,3	12,1	74,0	76,2	104,3

Figures for England/Wales (1835, 1850) exclude a figure (~100?) for spinning and weaving mills in Lancashire

** Wiltshire, Somerset and Gloucester. Totals for 1835 are not complete

Sources: Jenkins/Ponting, *British Wool (1987)*, 80, *Table 14: United Kingdom woollen industry*; Mann, *Cloth (1971)*, 220p.

¹⁴² County administrator and chief police director Haßlacher, 23.5.1853, DSTA BR 2116-50, F.495-96. *Factory of Nellessen: Nellessens information: 1146 workmen, 353 looms, 7000 spindles; Haßlachers estimate: 1689 workmen, 393 looms; Factory of Kuetgens: Kuetgens information: 85 workmen, 78 looms, 2100 spindles; Haßlachers estimate: 618 workmen, 160 looms.*

¹⁴³ Gregory, *Transformation* (1982), 63, suggests that factory returns for Yorkshire 1838 counted ‘*probably firms rather than mills*’.

¹⁴⁴ Jenkins, *West Riding* (1975), 68-69.

¹⁴⁵ The establishments counted in the 1851 census probably included employees of the domestic industry, the total number of establishments (and workers) should then be higher than the number of the mills.

Concerning the average employment per mill it seems as if the cloth factories in the west of the Rhineland, defined as establishments that used power machines and work machines, were at least as large as the factories of the West Riding (*table 12*). For 1849 the most comprehensive collection of data concerning Aix-la-Chapelle is available. These are, however, the figures partly constructed by the county administrator and chief director of police (see above); the employment and the number of looms are probably overestimated. In spite of alternative data, I employ these figures for a first preliminary evaluation. According to the general definition of the factory there were 19 cloth factories; they employed more than 8.200 working people (13% children). These factories processed 27.440 spindles for woollen yarn (either jennies or mules), and 1.150 working people were occupied with spinning and wool preparation.¹⁴⁶ On average the spinning and finishing machines were operated by only one steam engine at 15 h.p. (*table 12*).

It is unknown how many of the looms were processed inside of the factory workshops and how many home working weavers were occupied. Assumed that the factories accounted only for 2/3 of the looms and assumed that the number of employees is overestimated by 30%, the 19 factories had employed 1.400 looms and 5.750 employees within their establishments. The average number of employees would decrease to 300, the number of looms in the factory workshops to 70. Spinning had taken 20% of all the factory employees, weaving and preparing the loom probably 36% (1 ½ worker per loom). Most of the other employees were occupied with finishing processes (there were operations that could not be done by machines e.g. examining the cloth and removing knots, mending little holes, fixing the cloth at the tenter, transport within the factory). - These are data, of course, for the cloth factories. The average number of employment per firm (including putting-out clothiers) for all the 50 firms with more than 10 employees¹⁴⁷ had been higher than 110.

With respect to the West Riding, Gregory regards the decreasing number of employment per unit (*table 9*) as a proof of increased productivity compared to the West of England where the average number of employees rather raised.¹⁴⁸ But the comparison of employment per unit makes sense only if the range of vertical integration is similar; comparing scribbling and fulling mills with fully integrated cloth factories by employment per unit seems to be inadequate. The different structures of the production system should be considered. Gregory's argument is correct in case of mechanised scribbling and fulling mills, but this is different in the case of vertically integrated cloth factories.

Concerning these factories one has to consider (1) if the depth of integration has increased, and one has to look (2) at the product quality because fine cloth production depended to a great deal on manual labour. At that time most of the mills in the West Riding were still scribbling and fulling mills integrated into the domestic system; and spinning and weaving was the occupation of the cottage industry. Gregory himself assumes that in the 1850s 50% of the workforce was still occupied in the domestic industry,¹⁴⁹ *not* in factories.

¹⁴⁶ Gewerbe-Tabelle der Fabrikations-Anstalten und Fabrik-Unternehmungen aller Art des Regierungs-Bezirks Aachen für das Jahr 1849, in: DSTA BR 2116-48, F.319pp.

¹⁴⁷ I had to select with respect to employment in order to exclude handicraft workshops.

¹⁴⁸ Gregory, *Transformation* (1982), 66-68.

¹⁴⁹ Gregory, *Transformation* (1982), 69. See also the figures of Hudson (*table 8*, above).

Table 12: Cloth factories in Aix-la-Chapelle (town), 1849

Name of the factory owner	stages of production	ordinarily employed workforce				total	looms, steam engines, water mills
		< 14		> 14			
		male	female	male	female		
Nellessen, J.M. Sohn	spinning, weaving, Wal-kerei, dyeing	135	86	1.165	369	1.755	2 steam engines 3 water mills spinning and fulling, 1 outside the town 410 looms
Thywissen, Gebrüder	spinning, weaving, fulling	28	16	175	69	288	1 steam engines 1 water mill spinning and fulling 90 looms
Kesselkaul, Jos.	spinning, weaving, fulling, dyeing	45	30	585	165	825	2 steam engines, gas machine 200 looms
Wagner	spinning, weaving, fulling, dyeing	23	18	189	59	289	1 steam engine 80 looms
Van Houtem, Ignatz	spinning, weaving, fulling	18	10	45	20	93	1 steam engine 1 water millr spinning 25 looms
Visseur	spinning, weaving, fulling	36	21	298	146	501	2 steam engines 120 looms
Hochs, Friedr.	spinning, weaving, fulling, dyeing	25	14	168	85	292	1 steam engine 70 looms
Kuetgens, P.	spinning, weaving, fulling, dyeing	70	45	395	160	670	1 water mill spinning and fulling outside the town 160 looms
Startz, G.	spinning, weaving, fulling, dyeing	10	6	55	60	131	1 water mill spinning and fulling outside the town 1 steam engine 25 looms
Lingens	spinning, weaving, fulling, dyeing	44	31	320	116	511	1 water mill spinning and fulling outside the town 121 looms
Bischoff	spinning, weaving, fulling, dyeing	45	26	325	145	541	2 steam engine 125 looms
Knops	spinning, weaving	25	18	205	80	328	1 steam engine 93 looms
Deutz u. Bündgens	spinning, weaving	24	15	235	99	373	1 water mill spinning and fulling outside the town 100 looms
Deden, Arnold	spinning, weaving, fulling, dyeing	65	45	581	289	980	1 water mill spinning and fulling outside the town 2 steam engine 215 looms
van Gülpen	spinning, weaving, fulling	40	18	180	62	300	1 steam engine, gas machine 80 looms
Mara u. Lippmann	spinning, weaving, fulling, dyeing	10	8	98	32	148	1 water mill spinning and fulling 1 steam engine 70 looms
Jungbluth	spinning, weaving	4		30	41	75	1 water mill 30 looms
Mallinkrodt	spinning, weaving	5		65	18	88	1 steam engine 40 looms
Lob	spinning, weaving	2		30	4	36	1 steam engine 15 looms
totals	19 Firms	654	407	5.144	2.019	8.224	
totals	steam engines	water mills		looms		workforce	
average	20	11		2083		8224	
	1	0,5		110		433	

Source: Aachen, 3.7.1850, Königl. Landrath u. Polizei-Direktor, Nachweisung derjenigen Farbkationszweige, welche zusammen eine Anstalt bilden, in der Gewerbe-Tabelle der Fabrikations-Anstalten pp. des Regierungs-Bezirks für das Jahr 1849 aber in verschiedenen Kolumnen vertheilt sind, DSTA BR 2116-49, F.80pp.

Nevertheless, the range of the vertical integration of the cloth factories, the size range of the factories and the average number of employees (and the dominating types of products) are indicating that the structure of the industry of Aix-la-Chapelle (that is not identical with the cloth district of the west of the Rhineland) was more similar to the industrial structure of the West of England's cloth industry than to the cloth industry of the West Riding. Burtscheid and Eupen on the other hand were closer to the industrial structure of the West Riding. This is indicated by the higher rate of specialised spinning factories (in Burtscheid and Eupen) and specialised finishing firms (Eupen), and by the lower rate of vertically integrated fine cloth producers.¹⁵⁰ Apart from these industrial systems of cloth production the traditional system based on putting-out cloth merchants with centralised dressing workshops survived in Montjoie, but in the 1860s the whole industry of Montjoie collapsed.

The implementation of the "cloth factory" system changed the economy of the Rhenish woollen cloth industry; and the transition from commercial to industrial capitalism was finished by 1850. One of the reasons for different local developments could not be explained; that is the different structure of the local labour markets. As there were few opportunities for alternative occupation the cloth industry in Eupen or Montjoie could rest (partly) on putting-out workers; but the labour market of Aix-la-Chapelle offered various alternatives. This applied to qualified work (machine factories) and to simple work either for men (mining industry, needle industry, steel works) or for children and young women (cigar factories).

6. Markets, sales, and production

6.1 Markets and sales

Until the late 19th century woollens were the most important German export commodity. There is however no complete account of the woollen cloth exports, because the "Prussian tariff union" (*Preußischer Zollverein, 1818*) and the "German tariff union" of 1834 (*Deutscher Zollverein*) did not burden woollen cloth exports with tariffs. The first figures concerning the export of the "German tariff union" that are reliable to some degree stem from the 1860s. They are indicating the relevance of woollens, which amounted to roughly 20% of all the exports in 1864 (*table 13*). The tariffs did, however, not distinguish between woollen cloth and worsteds. Therefore, reasoning on woollen cloth export is to some degree speculative. *Table 14* shows details on the German woollen exports of 1864; exports to Belgium, to the Netherlands, to Hamburg, and to Bremen must generally be regarded as transit. Most of these products were subsequently shipped to the Americas or to Asia.

The German woollen cloth industry was internationally more competitive than the German worsted industry. Though the statistical data are not satisfying, the advantages can be estimated by import figures. The "German tariff union" imported scarcely any woollen yarn, as spinnery was '*advanced and since longest at one stage with the English, French and Belgian woollen yarn spinnery*'. It imported however substantial amounts of worsted yarn (11.000 tons).¹⁵¹ Also hardly any woollen cloth was imported to Prussia from the 1820s onwards¹⁵² because the '*foreign woollen cloth production could generally not compete with domestic factories*'.¹⁵³ Thus it may be assumed that woollen cloth had counted for the greater part of

¹⁵⁰ Nachweisung derjenigen Farbkationszweige, welche zusammen eine Anstalt bilden, in der Gewerbe-Tabelle [...] für das Jahr 1849 aber in verschiedenen Kolumnen vertheilt sind, DSTA BR 2116-49, Gewerbe-Tabelle der Fabrikations-Anstalten und Fabrik-Unternehmungen aller Art [...] 1849, BR 2116-48 F.180pp. (Burtscheid), F.209pp. (Eupen).

¹⁵¹ Bienengräber, *Statistik* (1868), 225.

¹⁵² Ferber, *Neue Beiträge* (1832), 101.

¹⁵³ Bienengräber, *Statistik* (1868), 228. Worsteds were estimated for 99% of all woollen imports.

the export revenue of 65 million *Reichsthaler* (all woollens). This development was not only based on industrial progress and increasing productivity. A second reason was the import tariff on woollen cloth (30 *Reichsthaler* per 55 kg) that was valid until 1865; but the cloth industries of most of the European states and of North America enjoyed a similar tariff protection.

Table 13: Exports of the German Zollverein, 1864 (the 24 most important products)

	million Rthlr.	%
1 woollens	65,4	21,2
2 cereals and seeds	38,3	12,4
3 silk products	30,6	9,9
4 dry goods	22,2	7,2
5 cotton products	17,8	5,8
6 timber	15,9	5,2
7 wool	13,9	4,5
8 linen	10,4	3,4
9 coal	9,8	3,2
10 brandy	9,6	3,1
11 cattle	9,2	3,0
12 flour	7,5	2,4
13 ironmongery	6,8	2,2
14 chemicals	6,4	2,1
15 books	6,4	2,1
16 zinc	5,6	1,8
17 raw cotton	5,2	1,7
18 potteries	5,2	1,7
19 fine wooden products	5,1	1,7
20 leather	4,0	1,3
21 flax	3,8	1,2
22 wine	3,6	1,2
23 glass and glass products	3,2	1,0
24 butter	2,9	0,9
	308,7	100,0

Table 14: Woollens. Export of the German Zollverein, 1864

	million Rthlr.	%
Belgium	20,82	31,85
Hamburg	14,35	21,95
Switzerland	8,58	13,13
Austria	7,78	11,89
Netherlands	6,89	10,54
Bremen	3,46	5,30
Russia and Poland	1,47	2,24
Holstein etc.	0,93	1,43
France	0,89	1,36
Mecklenburg	0,13	0,20
North Sea	0,04	0,05
East Sea	0,02	0,04
entrepots	0,01	0,01
	65,4	100

Source tables 13, 14: Bienengraber, Statistik (1868), 483-85.

The relevance of the woollen cloth industry of the west of the Rhineland can only be estimated, too. There is neither an account of the cloth export nor an account of the total cloth production. The temporary statisticians counted only the means of production (spindles, looms, and steam engines) believing being able to estimate total production with these indices; but machinery is only a first measure for capacity. Neither spindles nor looms are homogenous instruments. Spindles were adjusted to spinning-wheels, to jennies or to self-acting mules; there were small or broad looms that were operated by hand (with or without a fly-shuttle) or by a steam machine. Capacity and productivity would differ manifold. Also the utilisation of capacities was very volatile. The other thing the statisticians counted was the factories. The earliest data on the woollen cloth industry that cover the greater part of the German states stem from the 1861 census of the "German tariff union". It included data on so-called "factory establishments" (table 15) that are not strictly reliable. But as far as Prussia is concerned the figures seem to be rather exact as the Prussian methods of data collecting had seriously improved since 1837.¹⁵⁴ Taking for granted the validity of the data, the figures indicate that Aix-la-Chapelle was the leading region of the German woollen cloth industry. This does not concern the total number of so-called "factories" many of which in fact were only handicraft workshops, but the number of spindles per factory (*s/f*) and the number of looms per factory (*m/f*, *h/f*). If there is no other information, these relations are better indicators of productivity, and in both respects the Rhenish region was leading.

¹⁵⁴ From 1837 onwards each third year the Prussian factories were counted (Fabrikentabelle) and the methods improved. The problems of the returns are (1) that the criteria changed over the years, (2) that it is not always clear what the mayors counted, (3) that the owners of the factories did not provide the necessary informations.

Table 15: Woollen factories in the German Tariff Union, 1861 (factories, spindles, looms)

	woollen yarn					woollen cloth							
	"factories" %	spindles %	s/f	"factories" %	machine looms %	m/f	hand looms %	h/f					
Prussia	1095	61,6%	649197	58,1%	592,9	504	47,2%	1877	72,4%	3,7	8568	72,5%	17,0
of this: Rhine-Province	204	11,5%	259132	23,2%	1270,3	208	19,5%	1264	48,8%	6,1	3678	31,1%	17,7
of this: District Aix-la-Chapelle	107	6,0%	184405	16,5%	1723,4	103	9,7%	742	28,6%	7,2	3204	27,1%	31,1
Saxony	332	18,7%	303397	27,1%	913,8	135	12,7%	506	19,5%	3,7	1127	9,5%	8,3
Wuerttemberg	59	3,3%	41191	3,7%	698,2	74	6,9%	76	2,9%	1,0	527	4,5%	7,1
Thuringia	91	5,1%	40994	3,7%	450,5	50	4,7%	4	0,2%	0,1	321	2,7%	6,4
Totals German Tariff Union	1777	100,0%	1117862	100,0%	629,1	1067	100,0%	2592	100,0%	2,4	11818	100,0%	11,1

Sources: *Bienengräber, Statistik (1868), p.217; Ergebnisse der Volkszählung und Volksbeschreibung nach den Aufnahmen vom 3. Dezember 1861 (1864), 52pp., 90pp., 204pp.*

Table 16: Sales of the cloth industry, Aix-la-Chapelle and Burtscheid 1837-1848

	pieces produced	Prussian tariff union	South of Germany	North of Germany & Hanse States	Netherlands	Belgium	Switzerland	Italy, Napoli, Sicilia	Spain	Levante	China	North America
Aix-la-Chapelle												
1838	67.650	10,6%	10,3%	8,9%	13,3%	3,0%	6,7%	31,0%	4,4%	4,4%		7,4%
1840	62.100	12,9%	6,4%	4,8%	12,1%	1,6%	8,1%	28,3%	5,6%	6,4%	6,8%	7,2%
1844	65.280	12,9%	13,0%	8,7%	8,0%		10,4%	29,9%		1,5%	2,6%	7,7%
1847	70.100	9,6%	8,8%	7,7%	7,4%		8,0%	27,4%		2,1%		25,4%
Burtscheid												
1838	16.500	18,2%	15,2%	18,2%	12,1%	3,0%	6,1%	24,2%		3,0%		
1840	16.500	24,2%	15,2%	18,2%	12,1%		9,1%	16,4%		4,8%		
1844	17.100	24,6%	18,7%	19,9%	8,8%		11,7%	16,4%				
1847	18.720	13,9%	16,0%	16,0%	13,4%		11,8%	9,6%				19,3%
totals												
1838	84.150	12,1%	11,3%	10,7%	13,1%	3,0%	6,5%	29,7%	3,6%	4,2%		5,9%
1840	78.600	15,3%	8,3%	7,6%	12,1%	1,3%	8,3%	25,8%	4,5%	6,1%	5,3%	5,7%
1844	82.380	15,3%	14,2%	11,0%	8,1%		10,7%	27,1%		1,2%	2,1%	6,1%
1847	88.820	10,5%	10,4%	9,5%	8,7%		8,8%	23,6%		1,7%		24,1%

Source: *Wichterich, Entwicklung (1922), 191 (citing Archiv der Handelskammer Acta IV/18, originals destroyed)*

There are three reasons for the assumption that the woollen cloth industry of the Rhine-Province had the major share in the German exports: First of all, the Rhenish woollen fine cloth was favoured by import tariffs raised upon weight. The export of cheap and heavy coarse cloth did not equally pay. Secondly, the markets of the Rhenish region were export markets. Sales figures of the regional cloth industry that include the delivery area are only available for the period from 1838 to 1847 (Aix-la-Chapelle, city, and Burtscheid, *table 16*). They demonstrate that the Rhenish industry was export based. 90% of the woollen cloth was sold outside of the "German tariff union". The Italian states and North America were the most important markets, with America becoming the major customer. And thirdly, according to the data of *table 15* (above) the Rhenish woollen cloth industry is supposed to be more productive than the industries of the other German cloth districts.

North America became the most important customer of German cloth since the 1840s. Generally, fine woollen cloth was favoured by increasing American import tariffs on woollens, because they were raised upon weight. Its impact diminished with increasing product quality and higher prices.¹⁵⁵ The breakthrough on the North American market took place under the low tariff rates of 1846.¹⁵⁶ Arthur Cole reports that the share of English woollen cloth of all the North American imports decreased from 95% to 80-85% during the 1820s. Afterwards it increased again, but during the 1840s British woollen cloth and

¹⁵⁵ *Bienengräber, Statistik (1868), 227-229; Hudson, Genesis (1986), 168.*

¹⁵⁶ *Cole, Wool, vol. 1 (1926), 336-338.*

cassimere rapidly declined to 'little over 40 per cent' of the American imports (1849).¹⁵⁷ The dominance of British exports was challenged by continental European cloth producers. Especially German products were 'coming to the fore'¹⁵⁸. German cloth exports equalled 16% of the North American woollen cloth import in 1850; in 1860 it achieved 24%, ten years later 38%.¹⁵⁹ The main reason was the better dyeing of German cloth and the 'declining quality'¹⁶⁰ of British products.

This development is mirrored by the development in Aix-la-Chapelle and Burtscheid where the chamber of commerce observed the American markets very closely; its influence on the Rhenish cloth industry increased since the 1830s.¹⁶¹ While sales to North America were traditionally traded by Dutch, Flemish, and French houses, the regional producers started with direct distribution in North America in the 1830s and then in South America. *J.H. Kesselkaul*, for example, one of the large cloth producers of Aix-la-Chapelle, had direct sales contracts with many merchant houses in New York in the 1840s, and it settled e.g. a sales representative in Valparaiso.¹⁶² Within less than two decades North America became the most important export market. In 1843 the chamber of commerce analysed that the North American customers 'commenced preferring [Rhenish] products to British cloth'. According to the chamber, two reasons were relevant for this commencing development: (1) the local cloth was more 'solid' than British cloth, and (2) the local industry had successfully responded to changing fashions. This perception was confirmed by the chamber's yearly report of 1847.¹⁶³

The North American markets were very volatile and speculative. And with the increasing relevance of the overseas market the Rhenish cloth industry became more and more dependent on the American business cycles. The regional industrialists complained also about increasing international competition:¹⁶⁴ (1) The cloth industries of other German regions had the advantage of lower wages whereas the Rhenish wages were relatively high because the labour market of Aix-la-Chapelle offered various alternatives. This applied to qualified work (machine factories) as well as to simple work, either for men (mining industry, steel works) or for children and young women (cigar factories). (2) The British industry on the other hand had to pay higher wages; but there was also a productivity gap. The low costs of machines in Britain (~50% less than in Germany) favoured labour substitution, which increased labour productivity. The same cost advantages and, moreover, the cheaper raw materials, merino wool from Australia¹⁶⁵ resulted in increased capital productivity, too.

At the same time the importance of the American markets declined with respect to the West Riding, though North America remained the most important single market. The American share of all the West Riding's woollen cloth exports decreased from 40% to 30% (per value) from the 1820s to 1850; also the total exports receded. Unfortunately, there are only accumulated figures for woollens including worsteds. The latter suffered seriously by the competition of cotton textiles and this, probably, influenced strongly

¹⁵⁷ Jenkins/Ponting, *British Wool* (1987), 147, 148, table 26.

¹⁵⁸ Cole, *Wool*, vol. 1 (1926), 342-343.

¹⁵⁹ Jenkins/Ponting, *British Wool* (1987), 148, table 26.

¹⁶⁰ Jenkins/Ponting, *British Wool* (1987), 147.

¹⁶¹ E.g. the yearly report of 1837 regarded the American commercial crisis of 1837 and the cholera epidemia in Italy as being responsible for decreasing returns of the local cloth trade, *Jahresbericht der Handelskammer für Aachen und Burtscheid pro 1837*, 31.1.1838, DSTA Reg. Aachen 1540 II, F.253p.

¹⁶² Janssen, *Geschichte* (1940), 22.

¹⁶³ *Jahresbericht der Handelskammer für Aachen und Burtscheid pro 1843*, 31.1.1844, DSTA Reg. Aachen 1540 II, F.366; *Jahresbericht der Handelskammer für Aachen und Burtscheid pro 1847*, 30.3.1848, DSTA Reg. Aachen 1541, F.12.

¹⁶⁴ Handelskammer für Aachen und Burtscheid, *Jahresbericht* (1854), 1-4; Handelskammer für Aachen und Burtscheid, *Jahresbericht* (1853), 2-4.

¹⁶⁵ Hudson, *Genesis* (1986), 120.

the figure of all woollen exports. But if these figures were an indicator, exports were reduced by nearly 30% within 12 years. In the period of 1834 to 1836 the exports accounted for 3.707.000 £, then they were minimised to 2.596.000 £ in 1844-46.¹⁶⁶ The cloth industry shifted more and more towards the European markets (including the markets in the very east of Germany), and they developed the trade with the white dominions, with India, and with China.¹⁶⁷ Exports grew again in the next decades, but the shift to the new markets continued.

Table 17: Direction of export of British woollen and worsted cloth, 1856, and 1866 (by value)

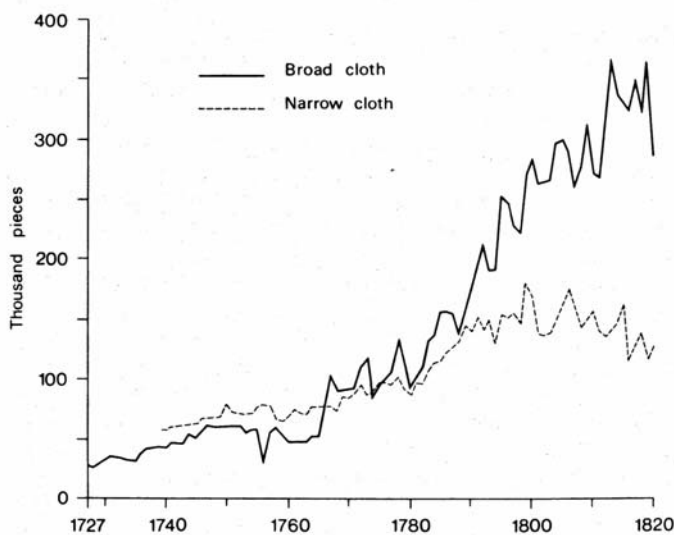
	Worsted		Woollens	
	1856 %	1866 %	1856 %	1866 %
Europe	40	43	13	19
United States	34	27	35	24
Colonies	15	12	23	25
Latin America	9	4	21	16
Far East etc.	2	14	8	17
Total exports (£m)	4,7	13,2	4,8	8,5

Source: Jenkins/Ponting, *British Wool* (1987), 163

6.2 Production

There is no sufficient information on cloth production in order to analyse the development of the two regions cloth production in the 19th century. Concerning the West Riding, there are published figures of fulfilled broad and narrow cloth for the period from 1726 to 1820 (*figure 6*).¹⁶⁸ For the following years there are only estimates on the whole British woollen cloth productions available that are however not very well based.¹⁶⁹

Figure 6: Broad and narrow cloth fulfilled in the West Riding, 1726-1820



Source: Gregory, *Transformation* (1982), 99.

¹⁶⁶ Gregory, *Transformation* (1982), 38.

¹⁶⁷ Hudson, *Genesis* (1986), 175. Jenkins/Ponting, *British Wool* (1987), 59, table 7, 68, table 11, provide data for the whole British industry.

¹⁶⁸ Mitchell/Deane, *Abstract* (1971), 189; Gregory, *Transformation* (1982), 104.

¹⁶⁹ Deane/Cole, *Growth* (1967), 196 and 196, table 47; Hudson, *Genesis* (1986), 240.

In spite of the reservations of the Rhenish entrepreneurs against providing the Prussian state with production figures, the chamber of commerce presented some production figures to the Frankfurt parliament in the revolutionary period of 1848 (*table 18*). These figures indicate not any increase of production from 1834 to 1847, but there is no proof for the reliability of the information. The figures also show an increasing number of looms (11%) and workmen (50%), which is not very plausible because production remained rather the same. The figures on looms and workers employed do also not correspond with the “lists of manufactures” and the “factory lists” of the respective years.

It is also possible to estimate production based on the production and on the number of workmen of single factories; but there is only a small amount of data available. The firm of *A. Deden* produced 6.000 pieces of cloth (980 workers) in 1850, *J.H. Kesselkaul* (825 workers) 4.400 pieces. They were the second and the third most important among the cloth factories of Aix-la-Chapelle according workmen. *J.M. Nellessen* was leading with 1.755 workers, but there is no data on the firm’s production.¹⁷⁰ These three firms employed more than 25% of all employees of the local woollen cloth industry.¹⁷¹ Based on the assumption of a fix relation of *workmen* and *output*, 72.000 pieces of cloth may have been produced in Aix-la-Chapelle in 1850; that would be close to the figures of *table 18*.

Table 18: Production of woollen cloth, Aix-la-Chapelle and Burtscheid 1838-1847

	pieces	looms operated		employed workers		costs of wool (Rthlr.)		productions costs (Rthlr.)			raw material and production costs		worth of the production (probably sales revenues)									
		total	per piece	total	per piece	55 kg	per piece	total	per piece	per worker	Rthlr.	per piece	Rthlr.	per piece								
Aix-la-Chapelle																						
1838	67.650	2.050	33,00	8.200	8,25	75,27	28,36	1.280.600	18,93	156,17	3.198.908	47,29	4.174.450	61,71								
1840	62.100	2.070	30,00	9.838	6,31	77,22	29,54	1.349.000	21,72	137,12	3.183.234	51,26	3.925.800	63,22								
1844	65.280	2.176	30,00	10.880	6,00	81,17	27,96	1.296.920	19,87	119,20	3.121.917	47,82	3.674.500	56,29								
1847	70.100	2.370	29,58	12.502	5,61	81,15	27,95	1.391.132	19,84	111,27	3.350.430	47,80	4.260.000	60,77								
Burtscheid																						
1838	16.500	500	33,00	2.000	8,25	76,10	27,33	332.000	20,12	166,00	783.017	47,46	957.000	58,00								
1840	16.500	550	30,00	2.618	6,30	71,86	26,09	342.800	20,78	130,94	773.266	46,86	946.260	57,35								
1844	17.100	570	30,00	2.850	6,00	77,04	28,15	358.400	20,96	125,75	739.690	43,26	1.031.000	60,29								
1847	18.720	624	30,00	2.660	7,04	77,07	28,03	391.535	20,92	147,19	916.285	48,95	1.036.000	55,34								
totals																						
1838	84.150	2.550	33,00	10.200	8,25	75,43	28,16	1.612.600	19,16	158,10	3.981.925	47,32	5.131.450	60,98								
1840	78.600	2.620	30,00	12.456	6,31	76,14	28,81	1.691.800	21,52	135,82	3.956.500	50,34	4.872.060	61,99								
1844	82.380	2.746	30,00	13.730	6,00	80,27	28,00	1.655.320	20,09	120,56	3.861.607	46,88	4.705.500	57,12								
1847	88.820	2.994	29,67	15.162	5,86	80,25	27,97	1.782.667	20,07	117,57	4.266.715	48,04	5.296.000	59,63								
Report of the chamber of commerce, Aix-la-Chapelle						80,00		27,27		1.270.000			15,88		3.400.000		43,15		4.000.000		50,00	
1834	80.000																					

Source: *Wichterich, Entwicklung (1922), 191 (citing Archiv der Handelskammer Acta IV/18, originals destroyed)*

The evidence is too weak for a serious evaluation. But if (1) the production of woollen cloth in Aix-la-Chapelle did remain stable during the ten years from 1838 until 1847, if (2) also the sales revenues of the cloth industrialists remained stable (*table 18*), and if (3) the West Riding’s production did correspond with the British export figures (a decline of 30% from 1834-46, see above), then the Rhenish industry had indeed been rather successful. However, the evidence is very weak.

7. Explanations for divergence and similarities

The implementation of the factory system in the two regions of the West Riding and the west of the Rhineland followed different lines that are analysed in this paper. The differences can be explained by the

¹⁷⁰ Janssen, *Geschichte* (1940), 23. Figures on the working people, 1849, table 11, above.

¹⁷¹ Tabellen und amtliche Nachrichten über den Preussischen Staat für das Jahr 1849, Bd. VI, Statistisches Bureau zu Berlin, Berlin 1855, 886pp.,

structure of the respective traditional system of cloth production and by different types of products, the similarities by production costs and by changing market conditions.

The emergence of the factory in the woollen cloth industry of the West Riding was related to the implementation of the scribbling and fulling mills of the 1780s and 1790s. Many of them employed steam engines from the early beginnings that often were only used as water hoisting machines. The scribbling mills concentrated on the production of slubbings; these were processed to yarn by domestic spinners (who mostly owned little spinning jennies). Most of the domestic spinners worked on behalf of clothiers, others sold the yarn on the market. The rate of vertically integrated firms was relatively low, yet there were firms like Benjamin Gott & Comp. in Leeds, which operated on a very large scale. Their number increased since the beginning of the 19th century. However, one of the remaining characteristics of the West Riding's industrial structure was the great number of firms working only on one or two stages of production (scribbling and fulling mills); these mills still counted for 50% in the 1830s. Though there were sometimes serious conflicts concerning the quality of work between the clothiers on the one hand and the runners of the fulling mills or the dressing masters on the other hand, this traditional industrial division of labour was preserved until the middle of the 19th century.

In the west of the Rhineland two different systems of industrial cloth production emerged since the 1810s. The dominating system was the vertically integrated "cloth factory" that was mainly established in the cities of Aix-la-Chapelle and Düren. These firms processed raw wool from scouring to woollen yarn, they wove the cloth, finished it to fine woollen cloth, and they even brought it to the international markets by own sales agencies. The cloth industry of the Rhineland obviously took the advantages of an industrial latecomer as explained by Gerschenkron's concept of "*economic backwardness*". In the first two decades of the 19th century the emerging cloth factories implemented up-to-date factory equipment that consisted on the one hand of complete sets of spinning machines comprehending the willy, scribbling and carding machines, slubbing billys, and spinning jennies¹⁷² and, on the other hand, of gig mills, shearing frames, pressing machines, gas heating etc. Labour conflicts regarding the implementation of machinery were only temporary.¹⁷³ In Aix-la-Chapelle woollen yarn was seldom sold or bought because the quality of yarn was not as easy to prove as the quality of raw wool. This changed with standardisation and physical and chemical testing instruments that were introduced in the last third of the 19th century. Specialised spinning firms emerged in the 1860s when also special weaving firms employing machine looms were established. The spinning firms produced for textile mass markets. They were increasingly employed by "cloth factories", and by new firms that just like modern trademark firms did not own any production unit (*betriebslose Unternehmen*).

The second system of industrial production developed in the towns of Burtscheid and Eupen where the firms were generally more specialised than in Aix-la-Chapelle and Düren. Based on sufficient equipment with water resources special firms for scouring (carbonisation) were established in Eupen and also mills that dyed cloth on behalf of clothiers of Aix-la-Chapelle and the neighbouring Belgium town of Verviers.¹⁷⁴ Several freestanding spinning factories in Eupen worked for the still existing small clothiers of the region, but they produced also special yarn that was used for mixed cloth. Other firms concentrated on dressing. These clothiers employed the spinning factories in order to spin the raw wool that they had

¹⁷² These spinning jennies were larger than the "simple" machines that were usually employed in the cottage industry of the West Riding, see: May, *Kammgarn-Maschinenspinnerei* (1826); Fahrbach, *Geschichte* (1932), 81; Heaton, *Yorkshire* (1965), 352.

¹⁷³ I could not address this issue in this paper but there were only two remarkable riots in the period of 1790 to 1840, one in Eupen in 1821 that opposed against shearing machines, the second uproar (1830 in Aix-la-Chapelle) was mainly opposed to wage shortages by the entrepreneurs, see: Venedey, *Darstellung* (1831); Volkman, *Strukturwandel* (1973); Althammer, *Herrschaft* (2002).

¹⁷⁴ On Verviers: Lebrun, *L'industrie* (1948).

bought, sorted and scoured to secure the quality of the product. They employed cheap putting-out workers for weaving to whom the local labour market did not offer any other possibility (this was different in Aix-la-Chapelle and its industrialised hinterland). However, from the 1830s onwards also in Eupen the number of integrated cloth firms increased. Generally, the local system of cloth production was based on medium qualities and it was closer to the main characteristics of the industrial system of the West Riding than to the characteristics of the fine-cloth industry of Aix-la-Chapelle. Different from the development of the West Riding, where the substitution of human labour by machines did change the industrial division of labour only to some degree (spinning remained a domain of the domestic industry). Domestic spinning in Eupen was completely replaced by independent economic organisations that produced woollen yarn for the regional cloth industry.¹⁷⁵

Henderson's view that *'only slow progress was made in extending the use of modern machinery in the German woollen and worsted industries'*¹⁷⁶ does obviously ignore the "economy" of the woollen cloth industry. Of course, the Rhenish industrialists followed the British "role model" with a time-lag of about 25 years, but progress was not slow. The industrialists rather modernised production very quickly, if they expected a "return on investment" and if the new machines were ready for the purposes of fine-cloth production.¹⁷⁷

The implementation of machinery into the different industrial systems of the West Riding and the west of the Rhineland was based on productivity increase and resulting cost advantages. The transition to the factory cannot be explained sufficiently by the concept of transaction costs. In fact, transaction costs were seriously reduced by the vertically integrated cloth factory, but probably they were of less importance than the reduction of production costs. The different developments in Aix-la-Chapelle (industrial labour markets) and Eupen (rural hinterland) indicate that factor costs have been very important. The Marglin hypothesis of "factory control" does also not comply with the evolution of the cloth factory (it is however applicable for an explanation of the emerging centralised manufactures in the 18th century when the merchant-clothiers integrated cloth finishing into centralised workshops and left only spinning and weaving to putting-out workers).

The development of the international cloth markets and the developing industry of North America was an important factor for strengthening the firms' respective competitive advantages. It seems that the West Riding suffered more from the competition of worsteds and cotton textiles than the fine-cloth producers of the west of the Rhineland; but the West Ridings products found new markets in the Far East. If this conclusion is correct the markets, on the one hand, supported the tendency towards mass production of medium (and lower) quality cloth in the West Riding and, on the other hand, they supported the tendency towards fine-cloth production in Aix-la-Chapelle. These products had already been the "typical" products of the "pre-industrial" period. The firms of both regions appear to have "preferred" moving on forward on their respective historical path and competence.

¹⁷⁵ Bemerkungen über die im Kreise Eupen vorhandenen Fabriken, 1.10.1816, DSTA Reg. Aachen 1567, F.8-10.

¹⁷⁶ Henderson, *Britain* (1954), 145.

¹⁷⁷ This interpretation applies to Julia Lacy de Mann's analysis of the cloth industry of the West of England.

References

- Art. "Fulling", in: Rees, Abraham (Hg.): The cyclopaedia or universal directory of arts, science, and literature (1819: 39 vol.; 1820: addit. 6 plates vol.), XV, London 1819
- Art. "Weaving", in: Rees, Abraham (Hg.): The cyclopaedia or universal directory of arts, science, and literature (1819: 39 vol.; 1820: addit. 6 plates vol.), XXXVIII, London 1819
- Art. "Wool", in: Rees, Abraham (Hg.): The cyclopaedia or universal directory of arts, science, and literature (1819: 39 vol.; 1820: addit. 6 plates vol.), XXXVIII, London 1819
- Art. "Woollen manufacture", in: Rees, Abraham (Hg.): The cyclopaedia or universal directory of arts, science, and literature (1819: 39 vol.; 1820: addit. 6 plates vol.), XXXVIII, London 1819
- Plates "Woollen manufacture", in: Rees, Abraham (Hg.): The cyclopaedia or universal directory of arts, science, and literature (1819: 39 vol.; 1820: addit. 6 plates vol.), Plates, vol. IV, London 1820
- Die Ergebnisse der Volkszählung und Volksbeschreibung nach den Aufnahmen vom 3. Dezember 1861, resp. Anfang 1862*, (Preussische Statistik, 5) Berlin 1864
- Althammer, Beate: *Herrschaft, Fürsorge, Protest. Eliten und Unterschichten in den Textilgewerbestädten Aachen und Barcelona, 1830-1870*, Bonn 2002
- Anonym, (Peters, Erich): *Das Eupener Tuchgewerbe. Seine Geschichte von den Anfängen bis zum Ende des 19. Jahrhunderts, 2 Teile. Nach einem unveröffentlichten Manuskript neu bearbeitet von Gottfried Loup*, (VoE Dokumente 1) Eupen 2000
- Anonymus: [Clermont, Johann Arnold von] *Freymüthige Betrachtungen eines Weltbürgers zum Wohle von Aachen bey Gelegenheit der bevorstehenden Constitutions-Verbesserung dieser Reichsstadt*, Frankfurt/Leipzig 1788
- Anonymus: *Die feine Tuchmanufaktur zu Eupen, ihre sämtlichen Geheimnisse, Vortheile und Preise nebst Tabellen*, Gotha 1796
- Anonymus: [vermutl. Peters, Erich] *Das Eupener Tuchgewerbe. Seine Geschichte von den Anfängen bis zum Ende des 19. Jahrhunderts, 2 Teile. Nach einem unveröff. Manuskript neu bearb. von Gottfried Loup*, (VoE Dokumente 1) Eupen 2000
- Barkhausen, Ernst: *Die Tuchindustrie in Montjoie, ihr Aufstieg und ihr Niedergang*, Aachen 1925
- Barkhausen, Max: *Verviers. Die Entstehung einer neuzeitlichen Industriestadt im 17. und 18. Jahrhundert*, in: VSWG 47 (1960) H. 3, 363-375
- Barlow, Arthur: *The History and Principles of Weaving by Hand and by Power. Reprinted, with considerable Additions, from "Engeneering", with a Chapter on Lace Making Machinery, reprinted from the "Journal of the Society of Arts", with several hundred Illustrations*, London 1878
- Beckers, Philomene: *Parteien und Parteienkampf in der Reichsstadt Aachen im letzten Jahrhundert ihres Bestehens*, in: Zeitschrift des Aachener Geschichtsvereins 53 (1935), 105-131
- Berg, Maxine: *The Age of Manufactures. Industry, Innovation and Work in Britain 1700-1820*, Oxford 1985
- Bienengräber, A.: *Statistik des Verkehrs und Verbrauchs im Zollverein für die Jahre 1842-1864 nach den Veröffentlichungen amtlicher Kommerzial-Übersichten etc.*, Berlin 1868
- Blumberg, Horst: *Die deutsche Textilindustrie in der industriellen Revolution*, Berlin/DDR 1965
- Bühl, Eduard: *Die Aachener Textilveredelungsindustrie und die Monschauer Tuchindustrie. Eine wirtschaftskundlich-geschichtliche Darstellung*, (masch. Diss. Köln) 1950
- Clapham, J.H.: *The Woollen and Worsted Industries*, London 1913
- Cole, Arthur Harrison: *The American Wool Manufacture*, vol. 1, Cambridge 1926
- Corsten, Walter: *Die Aachener Wirtschaft im ersten Drittel des 19. Jahrhunderts. Von der französischen zur preussischen Herrschaft*, (masch. Diss. Köln) 1925
- Crump, W.B. (Hg.): *The Leeds Woollen Industry 1780-1820*, (Thoresby Society. Publications 32) reprint New York/London 1967 [1931]
- Crump, W.B./Ghorbal, Gertrude: *History of the Huddersfield Woollen Industry*, Huddersfield 1935
- Deane, Phillis: *The Output of the British Woollen Industry in the Eighteenth Century*, in: Journal of Economic History 17 (1957), 207-223
- Deane, Phillis/Cole, W.A.: *British Economic Growth, 1688-1959. Trends and Structure*, Cambridge ²1967
- Dechêne, Karl: *Die Entwicklung der Aachener Tuchindustrie in der preussischen Zeit bis zum deutschen Zollverein im Jahre 1834*, (masch. Diss. Tübingen) 1923
- Dechesne, Laurent: *L'industrie drapière de la Vesdre avant 1800*, Paris 1926
- Ebeling, Dietrich: *Frühindustrialisierung zwischen Rhein und Maas. Überlegungen zu einer neuen Wirtschaftskarte der nördlichen Rheinlande um 1812*, in: RVJB 61 (1997), 175-204
- Ebeling, Dietrich: *Zünftige Handwerkswirtschaft und protoindustrieller Arbeitsmarkt*, in: Schmidt, Martin (Hg.): *Protoindustrie in der Region, Bielefeld 1997*, 321-346
- Ebeling, Dietrich: *Zunft Handwerk, Heimarbeit und Manufakturwesen in den Rheinlanden während des 18. Jahrhunderts*, in: Aufbruch in eine neue Zeit. Gewerbe, Staat und Unternehmer in den Rheinlanden des 18. Jahrhunderts, Köln 2000, 10-32
- Ebeling, Dietrich: *Möglichkeiten und Grenzen der Integration zünftiger Handwerkswirtschaft in eine frühneuzeitliche Gewerbezone am Beispiel der Aachener Feintuchproduktion*, in: Landesgeschichte als multidisziplinäre Wissenschaft. Festgabe für Franz Irsigler zum 60. Geburtstag, Trier 2001, 583-604
- Ebeling, Dietrich: *Die Entstehung eines frühindustriellen Arbeitsmarktes unter den Bedingungen der Modernisierung der Napoleonischen Zeit. Das Beispiel der Feintuchregion Aachen*, in: Unternehmen im regionalen und lokalen Raum 1750-2000, Leipzig 2004, 35-49
- Fahrbach, R.: *Die Geschichte der Streichwoll- und Kammwollspinnerei*, in: Johannsen, O. (Hg.): *Die Geschichte der Textilindustrie, Leipzig/Stuttgart/Zürich 1932*, 1-151
- Fehr, Martin: *Geschichte der Dürener Tuchmacher. Herausgegeben zum 75jährigen Jubiläum des Dürener Webervereins 1927*, Düren 1927
- Ferber, C. W.: *Beiträge zur Kenntniß des gewerblichen und commerciellen Zustandes der preußischen Monarchie. Aus amtlichen Quellen*, 2 Bde., Berlin 1829
- Ferber, C. W.: *Neue Beiträge zur Kenntniß des gewerblichen und commerciellen Zustandes der preußischen Monarchie. Aus amtlichen Quellen*, Berlin 1832
- Ganser, Carl: *Die Wirkungen der französischen Herrschaft, Gesetzgebung und Verwaltung auf das Aachener Wirtschaftsleben*, (masch. Diss. Tübingen) 1922
- Gobert, Théodore: *Conditions de l'industrie du tissage à la fin de l'ancien régime. Les Cockerill à leur début*, in: Bulletin des L'Institut Archéologique Liégeois XLI (1911), 155-186
- Gregory, Derek: *Regional Transformation and the Industrial Revolution. A Geography of the Yorkshire Woollen Industry*, Minneapolis 1982
- Hammer, Maria: *Geographische Betrachtungen des Wollgewerbes am Rande des Hohen Venns*, (Aachener Beiträge zur Heimatkunde, 19) Aachen 1937

- Handelskammer für Aachen und Burtscheid: *Jahresbericht der Handelskammer für Aachen und Burtscheid für 1852ff.*, Volume, Aachen
- Heaton, Herbert: *The Yorkshire Woollen and Worsted Industries. From the Earliest Times up to the Industrial Revolution*, Oxford 1965
- Heizmann, Hans Friedrich: *Die wirtschaftliche und rechtliche Lage der arbeitenden Klassen in Aachen um die Wende des 18. Jahrhunderts*, (masch. Diss. Tübingen) 1923
- Henderson, William O.: *Britain and Industrial Europe 1750-1870. Studies in British Influence on the Industrial Revolution in Western Europe*, (3rd ed. 1972) Liverpool 1954
- Henkel, Martin: *Tagelohn, Tradition und Revolution. Ein Tarifvertrag aus dem Jahre 1790*, in: *IWK* (1989) 1, 42-66
- Hermanns, Leo: *Die Tuchscherer. Eupens erste solidarische Arbeiterschaft*, in: *Geschichtliches Eupen* 16 (1982), 150-171
- Hitch, Alan: *Roving Billy Cockerill and Sons. The story of a Rossendale man who helped bring the Industrial Revolution to Europe*, 1997
- Hodges, Theodore: *The Iron King of Liège: John Cockerill*, (Ph.D. Columbia University) 1960
- Hudson, Pat: *The Genesis of Industrial Capital. A Study of the West Riding Wool Textile Industry c. 1750-1850*, Cambridge e.a. 1986
- Hudson, Pat: *The Industrial Revolution*, London 1992
- Hudson, Pat: *Proto-Industrialization: the case of the West-Riding wool textile industry in the eighteenth and early nineteenth centuries*, in: Jenkins, D.T. (Hg.): *The Textile Industries*, Oxford 1994, 85-111
- Janssen, Wilhelm L. (Bearb.): *Geschichte der Firma "J.H.Kesselkaul Enkel", Tuchfabrik in Aachen 1815-1940. Ein Beitrag zur Geschichte der Aachener Tuchfabrikation*, Aachen 1940
- Jenkins, D.T.: *Early factory development in the West Riding of Yorkshire, 1770-1800*, in: Harte, N.B./Ponting, K.G. (Hg.): *Textile History and Economic History*, Manchester 1973, 247-280
- Jenkins, D.T.: *The West Riding Wool Textile Industry, 1770-1835. A Study of Fixed Capital Formation*, Edington 1975
- Jenkins, D.T./Ponting, K.G.: *The British Wool Textile Industry, 1770-1914*, Aldershot 1987
- Jenkins, John Geraint: *The Welsh Woollen Industry*, Cardiff 1969
- Johannsen, Otto (Hg.): *Die Geschichte der Textil-Industrie*, Leipzig/Stuttgart/Zürich 1932
- Kermann, Joachim: *Die Manufakturen im Rheinland 1750-1833*, (Rheinisches Archiv, 82) Bonn 1972
- Kisch, Herbert: *The Textile Industries in Silesia and the Rhineland. A Comparative Study in Industrialisation*, in: *Journal of Economic History* 19 (1959), 541-564
- Kisch, Herbert: *The impact of the French Revolution on the Lower Rhine textile district - some comments on economic development and social change*, in: *EHR* 15 (1962) No. 2, 305-327
- Kisch, Herbert: *Growth Deterrents of Medieval Heritage. The Aachen-area Woolen before 1790*, in: *JEH* 24 (1964) No. 4, 517-537
- Kisch, Herbert: *Die hausindustriellen Textilgewerbe am Niederrhein vor der industriellen Revolution - von der ursprünglichen zur kapitalistischen Akkumulation*, (Veröffentlichungen des Max-Planck-Instituts für Geschichte, 65) Göttingen 1981
- Kjellberg, Sven T.: *Ull och Ylle. Bidrag till den Svenska Yllemanufakturens Historia*, Lund 1943
- Kley, Heribert: *Geschichte und Verfassung des Aachener Wollenambachts wie überhaupt der Tuchindustrie der Reichsstadt Aachen. Ein Beitrag zur Entwicklung der deutschen Tuchindustrie und des Zunftwesens*, (Diss. Bonn) Siegburg 1916
- Korr, Anton: *Die Einführung der Dampfkraft in die Aachener Industrie bis zum Jahre 1831*, (masch. Diss. Tübingen) 1921
- Kraus, Thomas R.: *Auf dem Weg in die Moderne. Aachen in französischer Zeit, 1792/93, 1794-1814*, (Handbuch-Katalog zur Ausstellung im "Krönungssaal" des Aachener Rathauses vom 14. Januar bis zum 5. März 1995) Aachen 1994
- Krüger, Horst: *Zur Geschichte der Manufakturen und der Manufakturarbeiter in Preußen*, Berlin 1958
- Kunth, G. J. Chr.: *Bericht über die Regierungs-Departements von Trier, Coblenz, Cöln, Aachen und Düsseldorf vom 12. Oktober 1816*, in: Goldschmidt, F. u. P. (Hg.): *Das Leben des Staatsrath Kunth*, Berlin 1888, 181-246
- Lebrun, Pierre: *L'industrie de la laine à Verviers pendant le XVIIIe et le début du XIXe siècle. Contribution à l'étude des origines de la révolution industrielle*, (Bibliothèque de la Faculté de Philosophie et Lettres de l'Université de Liège, 114) Liège 1948
- Lipson, E[phraim]: *The History of the Woollen and Worsted Industries*, (The Histories of the English Industries) London 1921
- Macco, Hermann Friedrich: *War Johannes Wespian Tuchfabrikant?* in: *ZAGV* 33 (1911), 83-89
- Mahaim, Ernest: *Les débuts de l'établissement John Cockerill à Seraing. Contribution à l'histoire des origines de la grande industrie au Pays de Liège*, in: *VSWG* (1905), 627-648
- Mann, Julia de L.: *The Textile Industry: Machinery for Cotton, Flax, Wool, 1760-1850*, in: Singer, Ch. u.a. (Hg.): *A History of Technology. Vol IV: The Industrial Revolution c1750 to c1850*, Oxford 1958, 277-307
- Mann, Julia de Lacy: *The Cloth Industry in the West of England from 1640 to 1880*, Oxford 1971
- Marglin, Stephen A.: *What do bosses do? The origins and functions of Hierachy in Capatalist Production*, in: Gorz, A. (Hg.): *The Division of Labour: The Labour Process and Class-Struggle in Modern Capitalism*, Brighton 1976
- Marx, Karl: *Das Kapital. Kritik der Politischen Ökonomie: Erster Band*, (Karl Marx/Friedrich Engels: Werke, Bd. 23) Berlin (DDR) 1977 [1867]
- May, [Johann Georg]: *Über Kammgarn-Maschinenspinnerei und Vergleichung einiger Proben von Maschinen-Kammgarn mit dergleichen inländischen Maschinen- und Hand-gespinnsten*, in: *Verhandlungen des Vereins zur Beförderung des Gewerbefleißes in Preußen* 5 (1826), 98-103
- Mitchell, B.R./Deane, Ph.: *Abstract of British Historical Statistics*, Cambridge 1971
- Mokyr, Joel: *Editor's Introduction: The New Economic History and the Industrial Revolution*, in: Mokyr, J. (Hg.): *The British Industrial Revolution. An Economic Perspective*, 2nd edition, Oxford u.a. 1999, 1-127
- Müller, Jürgen: *1798. Das Jahr des Umbruchs im Rheinland*, in: *RVJB* 62 (1998), 205-237
- Müller, Klaus: *Studien zum Übergang vom Ancien Régime zur Revolution im Rheinland. Bürgerkämpfe und Patriotenbewegung in Aachen und Köln*, in: *RVJB* 46 (1982), 102-160
- Müller, Klaus: *Die Reichsstadt Aachen im 18. Jahrhundert*, in: *Zeitschrift des Aachener Geschichtsvereins* 98/99 (1992/93) Teil II, 205-230
- Nemnich, Philipp Andreas: *Tagebuch einer der Kultur und Industrie gewidmeten Reise, 2 Bde.*, Tübingen 1809
- Paffen, Maria: *Die gewerbliche Verwendung der Wasserkraft in Aachen vom späteren Mittelalter bis zum Anfang des 19. Jahrhunderts*, (Diss. Köln) Aachen 1928
- Pasleau, Suzy: *John Cockerill. Itinéraire d'un géant industriel*, Allleur-Liège 1993
- Pfister, Ulrich: *Protoindustrielle Produktionsregimes in institutionenökonomischer Perspektive*, in: Ellerbrock, K.-P./Wischermann, C. (Hg.): *Die Wirtschaftsgeschichte vor der Herausforderung durch die New Institutional Economics*, Dortmund 2004, 160-178

- Rees, Abraham: *The cyclopaedia or universal directory of arts, science, and literature* (1819: 39 vol.; 1820: addit. 6 plates vol.), London 1819/20
- Reinick, H.A. von (Hg.): *Statistik des Regierungsbezirks Aachen in amtlichem Auftrag herausgegeben von H.A. Reinick, 3 Bde.*, Aachen 1865-1867
- Ritter, G.: *Die Tuchindustrie*, in: Festschrift zur 36. Hauptversammlung des Vereins deutscher Ingenieure, Aachen 1895, 129-135
- Schmidt, Martin: *Burtscheid. Eine Tuchmanufakturstadt um 1812*, (Geschichtlicher Atlas der Rheinlande, Beih. 7; Wirtschafts- und Verkehrsgeschichte, 8) Köln 1997
- Schmidt, Martin: *Tuchmanufakturen in der Region Aachen. Frühneuzeitliche Werkbauten als Spiegel einer Betriebsform zwischen Verlag und zentralisierter Produktion*, in: Ebeling, D. (Hg.): *Aufbruch in eine neue Zeit*, Köln 2000?
- Schmidt, Martin: *Burtscheid. Ein Standort der Tuchindustrie in der Region Aachen vor der Fabrikindustrialisierung*, in: Heß, U., et al. (Hg.): *Unternehmen im regionalen und lokalen Raum 1750-2000*, Leipzig 2004, 51-71
- Schmoller, Gustav: *Zur Geschichte der deutschen Kleingewerbe im 19. Jahrhundert. Statistische und nationalökonomische Untersuchungen*, Halle 1870
- Schoeller, August Victor: *Geschichte der Familie Schoeller*, Berlin 1894
- Schollen, Mathias: *War Johannes Wespian Tuchfabrikant?* in: ZAGV 33 (1911), 89-99
- Schoop, August: *Rechts- und Wirtschaftsgeschichte der Stadt Düren bis 1794*, Bonn 1920
- Schoop, August: *Geschichte der Stadt Düren bis zum Jahre 1816*, Düren 1923
- Schulte-Krumpen, B.: *Die Entwicklung der Industrien des Kreises Düren von 1543 bis zum Jahre 1921*, (Diss. Köln) 1922
- Seidl, Anton: *Die Aachener Wollenindustrie im Rahmen der rheinischen bis zur Gewerbefreiheit 1798*, (masch. Diss. Köln) 1923
- Smail, John: *Merchants, Markets and Manufacture. The English Wool Textile Industry in the Eighteenth Century*, Basingstoke 1999
- Strauch, Josef: *Die Aachener Tuchindustrie während der französischen Herrschaft 1794-1814*, (Diss. Münster) 1922
- Stuhlmann, Friedrich/Scheins, Martin: *Zwei Geschäftsreisen Aachener Großkaufleute in das östliche und nördliche Europa im 18. Jahrhundert*, in: ZAGV 35 (1913), 259-317
- Teuteberg, Hans-Jürgen: *Das deutsche und britische Wollgewerbe um die Mitte des 19. Jahrhunderts. Ein Beitrag zur quantitativ-komparativen Wirtschaftsgeschichte*, in: Winkel, H. (Hg.): *Vom Kleingewerbe zur Großindustrie. Quantitativ-regionale und politisch-rechtliche Aspekte zur Erforschung der Wirtschafts- und Gesellschaftsstruktur im 19. Jahrhundert*, Berlin 1975, 9-103
- Venedey, Jakob: *Darstellung der Verhandlungen vor den Assisen zu Köln über die Teilnehmer an den am 30. August 1830 in Aachen stattgehabten Aufruhr, nebst Schlußbemerkungen*, Köln 1831
- Viebahn, Georg W. von: *Über Leinen- und Wollmanufakturen, deren Ursprung, Umfang und Leistungen in Deutschland, deren Werth und Fortschritte*, (Flugschriften 1846-1847: staatswirtschaftlich, 1) Berlin 1846
- Viebahn, Georg W. von: *Statistik des Zollvereins und nördlichen Deutschlands, 3. Teil: Thierzucht, Gewerbe, Politische Organisation*, Berlin 1868
- Volkman, Heinrich: *Wirtschaftlicher Strukturwandel und sozialer Konflikt in der Frühindustrialisierung. Eine Fallstudie zum Aachener Aufruhr von 1830*, in: Kölner Zeitschrift für Soziologie und Sozialpsychologie Sonderheft 16 (1973), 550-565
- von Tunzelmann, G.N.: *Steam Power and British Industrialization to 1860*, Oxford 1978
- Wachs, Alexander: *Die volkswirtschaftliche Bedeutung der technischen Entwicklung der deutschen Wollindustrie*, (Technisch-volkswirtschaftliche Monographien, VII) Leipzig 1909
- Wehler, Hans-Ulrich: *Deutsche Gesellschaftsgeschichte. 1. Bd.: Vom Feudalismus des Alten Reichs bis zur Defensiven Modernisierung der Reformäre 1700-1815*, München 1987
- Weingarten, Hans-Friedrich: *Die Tuchindustrie in Montjoie. Ein Beitrag zur Geschichte der rheinischen Tuchindustrie*, (masch. Diss. Köln) 1922
- Wichterich, Richard: *Die Entwicklung der Aachener Tuchindustrie von 1815-1914*, (masch. Diss. Köln) 1922
- Wilson, R.G.: *Gentlemen Merchants. The merchant community in Leeds 1700-1830*, Manchester 1971
- Wilson, R.G.: *The supremacy of the Yorkshire cloth industry in the eighteenth century*, in: Harte, N.B./Ponting, K.G. (Hg.): *Textile History and Economic History*, Manchester 1973, 225-246
- Winzen, Kristina: *Auseinandersetzungen im Aachener Tuchgewerbe in der Mitte des 18. Jahrhunderts. Reichsstadt und Reichshandwerksordnung*, (masch. MA-Arbeit Universität zu Bonn) 1994
- Zunkel, Friedrich: *Gewerbe- und Industrielandschaften von der Frühindustrialisierung bis 1914. Wolle*, in: Pohl, H. (Hg.): *Gewerbe- und Industrielandschaften vom Spätmittelalter bis ins 20. Jahrhundert*, 1986, 254-283.