Storia economica

ANNO XXI (2018) - n. 2

Edizioni Scientifiche Italiane

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Registrazione presso il Tribunale di Napoli al n. 4970 del 23 giugno 1998.
Responsabile: Luigi De Matteo.

Periodico esonerato da B.A.M. art. 4, 1° comma, n. 6, d.P.R. 627 del 6 ottobre 1978

SOMMARIO

ANNO XXI (2018) - n. 2

ARTICOLI E RICERCHE

NOTE E INTERVENTI

RECENSIONI E SCHEDE

DIVISION OF LABOUR, SALARIES AND PRODUCTIVITY IN BARCELONA'S *INDIANAS* MANUFACTURE IN THE XVIII CENTURY*

Calico production (*indianas*) could be considered one of the first forms of industrial production based on the factory model. In this vein, this case study reports on the presence of a factory organization based on labour division and managerial structure. Nevertheless, the model still maintains aspects typical of craft and guild-based production, such as the low level of technology and the importance of skilled labour for the value-added production phases. The study represents an attempt to describe the division of labour within the manufacture, calculate the productivity of different factors of production with a special attention to work productivity, trying to verify the existence of a correlation between skilled work productivity and output.

Calico printing, skilled work, productivity, division of labour

La produzione di calicò (indianas) può essere considerata una delle prime forme di produzione industriale basata sul modello di fabbrica. Nell'ambito di questo filone di ricerca, il case study analizzato rivela la presenza di un'organizzazione produttiva basata sulla divisione del lavoro e sull'organizzazione manageriale. Nonostante tali aspetti di modernizzazione, il modello mantiene ancora elementi tipici della produzione artigianale e corporativa, come il basso livello di tecnologia e l'importanza della manodopera qualificata per le fasi di produzione a valore aggiunto. Lo studio rappresenta un tentativo di descrivere e analizzare la divisione del lavoro all'interno della manifattura, calcolare la produttività dei diversi fattori di produzione con un'attenzione particolare alla produttività del lavoro, cercando di verificare l'esistenza di una correlazione tra produttività del lavoro qualificato e produzione.

Stampa di tessuti, lavoro qualificato, produttività, divisione del lavoro

* I would like to thank Paolo Coccorese, Alberto Guenzi and Luca Mocarelli for their helpful comments. Usual disclaimers apply.

 ISSN 1824-5064

Introduction

In the first half of the seventeenth century, woollen fabrics began to be gradually supplanted by colourful cotton fabrics from India, Egypt and Malta. Cotton fabrics responded better to fashion and the new exigencies of European consumers. They could be washed more frequently, as well as offering greater strength and greater resilience of colour. The success of cotton textiles in the European market was supported by the role played by domestic demand, which followed a steady growth trend, pushed by the good results of the primary sector. In fact, fashion and consumer tastes became – at a time of increased purchasing power – conditioning elements of the demand.

The widespread use of cotton accelerated at the beginning of the XVIII century when the availability of raw material increased, due to the cultivation of new plantations in the American colonies, in India and China; this prompted an influx onto European markets of a substantial amount of raw cotton fabric at much more competitive prices than previous imports from Egypt[1]. In addition, the availability of semi-finished product (yarn cotton) grew enormously due to technological innovations – beginning with James Hargreaves' *Jenny* (1764) and Richard Arkwright's *Mule* (1771) – gradually supplanting the use of wool in mass textile production[2].

The impact of technological change on labour markets – and its effects on wage differentiation – is a strategic topic for economic historians. The debate and research on wage inequality in the U.S. in the past century highlighted the relationship between skilled labour and productivity increase. The consequence of such transformation was the increasing demand for skilled workers and increasing inequality between them and unskilled workers[3]. It is possible to affirm that the complementarity concerning technology and skill grew

[1] D.A. Farnie, *The role of merchants as prime movers in the expansion of the cotton industry, 1760-1990*, in *The Fibre that Changed the World. The Cotton Industry in International Perspective, 1600-1990s*, ed. by D.A. Farnie and D.J. Jeremy, Oxford University Press, Oxford 2004, pp. 15-55; O. Prakash, G. Riello, T. Roy, K. Sugihara, *How India Clothed the World: The World of South Asian Textiles, 1500-1850*, Brill, The Hague 2009, pp. 4-6.

[2] I. Turnau, *The organization of the European textile industry from XIII*th *to XVIII*th *century*, «The Journal of European Economic History», 17 (1998), pp. 583-602.

[3] D. Card, J.E. Di Nardo, *Skill-Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles*, «Journal of Labor Economics», 20 (2002), pp. 733-783.

ISSN 1824-5064

during the technological revolutions[4]. The question is whether such complementarity has always existed, or whether it is a more recent phenomenon. The traditional approach is based on the fact that the rise of technology led to a progressive skill loss among the workers. Literally, machines, capital and, finally, unskilled labour supplanted skilled workers. Nevertheless, in more recent times, a growing number of new studies deal with the hypothesis of a non-linear transformation of work under the pressure of new technology[5].

We can hypothesize that the problem of skilled workers is related to the diffusion of the new production mode based on the factory. The use of new technology under a factory-based production mode led to the necessity to implement pay and performance monitoring. In general, the link between remuneration and worker activity will be stronger where performance is more accurately measured (this is the case of piece rates). So we can suppose that piece rate organization of work could better fit in a factory with a standardized production or one in which workers perform the same tasks repetitively. In contrast, where workers perform a wide range of duties varying from day to day, it is difficult and expensive to set up a piece-rate system[6]. More trivially, we can affirm that the method of pay is influenced by job characteristics, skill level and the importance of the quality of the output. Therefore, high-skilled jobs should gain greater benefit from accurate supervising, and the use of piece rates rather than standard rates[7].

The dichotomy between piece rates and fixed rates calls into question the role of management and its power to control and organize production. The first problem is to set the piece rate correctly in or-

[4] C. Goldin, L. Katz, *The Origins of Technology-Skill Complementarity*, «Quarterly Journal of Economics», 113 (1998), pp. 693-732; D. Autor, L. Katz, A. Krueger, *Computing Inequality: Have Computers Changed the Labor Market?*, «The Quarterly Journal of Economics», 113 (1999), pp. 1169-1214.

[5] Goldin, Katz, *The Origins of Technology-Skill Complementarity*, p. 700; A. Ciccone, *Falling Real Wages During an Industrial Revolution*, Working paper, Universitat Pompeu Fabra, 195 (1996); D. Acemoglu, *Technical Change, Inequality and the Labor Market*, «Journal of Economic Literature», 40 (2002), pp. 7-72; K.H. O'Rourke, A.S. Rahman, M. Taylor, *Luddites, the Industrial Revolution and the Demographic Transition*, «Journal of Economic Growth», 18 (2013), pp. 373-409, and L.F. Katz, R.A. Margo, *Technical Change and the Relative Demand for Skilled Labor: The United States in Historical Perspective*, «NBER Working Paper» 18752 (2013).

[6] C. Brown, *Firms' choice of method of pay*, «Industrial and Labor Relations Review», Special Issue, 43 (1990), pp. 165-182.

[7] D. Beach, *Personnel: The Management of People at Work*, MacMillan, New York 1975[3], p. 312; Brown, *Firms' choice of method of pay*, p. 172.

 ISSN 1824-5064

der to measure the workers' performance. In this case, it is possible that the management did not know how fast a job could be done, and could not use a worker's performance to determine the correct rate because the worker could respond by restricting output[8].

Early research works on employer-worker relations in the eighteenth and nineteenth centuries show that enterprises were able to contract a low-cost workforce. The archival sources demonstrate how the first skilled factory workers based their wages on a «customary and not a market calculation»[9]. In this way, the worker fixed a relative wage rate, assuming a standard day of work. The worker's evaluation of his own work was undermined by a weak bargaining position, so the enterprises could contract skilled workers at below market cost, benefiting, at the same time from the new technologies and new work organization.

During the pre-factory stage, under the putting-out system or cottage-manufacture, the workers developed a sort of standard reasonable wage, calculated on a fair day, considering the market conditions. The case of the cotton mills of Lancashire in the XVIII century shows us that the first generation of factory workers was not prepared to calculate exactly the right salary. These workers brought with them to the new factories the idea of a right and reasonable wage as a negotiation means with factory owners who limited such requests by threatening workers with replacement by women or children[10].

The managerial structure and the work factor prices had direct implications for factory discipline, which is an important aspect of labour productivity. Pollard considers the new work discipline in the emerging factories in eighteenth century Britain a crucial aspect of modern management[11]. In particular, he highlighted the problems of introducing regularity and stability of work in a workforce that came from the

[8] R. Edwards, *Contested Terrain. The Transformation of the Workplace in the Twentieth Century*, Basic Books, New York 1979, pp. 59-60; D. Clawson, *Bureaucracy and the Labor Process*, Monthly Review Press, New York 1980, pp. 123-125; R. Gibbons, *Piece-Rate Incentive Schemes*, «Journal of Labor Economics», 5 (1987), pp. 413-442.

[9] E.J. Hobsbawm, *Labouring Men: Studies in the History of Labour*, Weidenfeld and Nicolson, London 1964, p. 345.

[10] M. Huberman, *Industrial Relations and the Industrial Revolution: Evidence from M'Connell and Kennedy, 1810-1840*, «Business History Review», 65 (1991), pp. 345-378.

[11] S. Pollard, *The Genesis of Modern Management: A study of the industrial revolution in Great Britain*, Harvard University Press, Cambridge (Mass.) 1965, p. 160.

ISSN 1824-5064

shop-floor and the putting-out system, and were not accustomed to a continuous monitoring process. The change in the characteristics of a working day – mainly based on an increased effort by the worker – were also prompted by a rigorous system of penalties and incentives[12].

This paper is based on primary sources (mainly accounting records) kept at the Archivo de la Ciudad de Barcelona. In particular, the research has elaborated the data set represented by the payment rolls of J.B. Sires & Co. for almost 30 years. The detailed information about workers' tasks and salaries allowed the reconstruction of trends for skilled and unskilled workers within the firm. Business and accounting records have many advantages for the economic historian. While leaflets, newspapers, gazettes, etc. are quite vague and maybe generalized, firm records are specific and often quantitative. Due to their nature, the internal records of a firm are intended to give accurate information both to the management and to stakeholders or external auditors. «Payrolls, ledgers, intrafirm memoranda and correspondence, can be made to yield up reliable evidence on the topics under consideration here»[13].

The case study: the factory of J.B. Sires & Co.

The first information we have about a manufacture owned by Juan Baptista Sires dates back to 1769, the date of the first account book that reports the supply of *indianas* to different customers[14]. Arguably, the company had existed for some years, founded by Juan Baptista, who was the son of a Barcelona *droguero* (a trader of products for textiles dyeing), probably in the early 1760s, thanks to the experience acquired in the dyeing process. In fact, a much more comprehensive document dates from the following year, when the company founded among Sires, the manufacturer of silk veils Joseph Aymar and Francesc Fraginals, was officially established with the name Juan Baptista Sires

[12] S. Pollard, *Factory Discipline in the Industrial Revolution*, «The Economic History Review», New Series, 16 (1963), pp. 254-271; G. Clark, *Factory discipline*, «The Journal of Economic History», 54 (1994), pp. 128-163; B. Gupta, *Wages, unions, and labour productivity: evidence from Indian cotton mills*, «The Economic History Review», 64 (2011), pp. 76-98.

[13] R. Ginger, *Labor in a Massachusetts Cotton Mill, 1853-60*, «The Business History Review», 28 (1954), p. 68.

[14] Archivo Historico de la Ciudad de Barcelona (thereafter AHCB), *Fons Comercial*, B 228.

 ISSN 1824-5064

& Co[15]. In 1772, the three partners expanded the base of the company, associating Alegre & Gibert, a large commercial company owned by Miguel Alegre and by the shareholder Agusti Gibert Jr. The company Alegre & Gibert, however, brought with it a pioneering and extensive trade network specializing in cotton products[16].

In the division of roles between the members of J.B. Sires & Co., Joseph Aymar took the position of *fabricante* (manufacturer), with responsibility for overseeing the preparation of colours and stains and the application process on raw canvas; Aymar was also in charge of selecting the staff and allocating them to different productive phases[17]. Francesc Fraginals would take care of the commercial side, dispatching the finished *indianas* to customers. As can be seen from the inventory drawn up on the merger of manufactures, the joint stock (current assets) amounted to 26,543 Catalan *lliures* of which 21,015 Catalan *lliures* from Alegre and 5,528 from J.B. Sires & Co.[18]

The work organization

The case of the manufacture J.B. Sires shows perfectly the coexistence of working capital with salaried workers. This seems to be the first element of the separation of *indianas* manufacture from traditional textile manufacturing craftsmanship[19].

The structure of work in the textiles workshops (wool, silk and even cotton) that had characterized the European proto-industrial pattern was still deeply tied to a guild model based on the binomial: shopkeeper – shop boy (apprentice), with the addition of specialized

[15] R. Rossi, *La manifattura cotoniera a Barcellona tra innovazione e persistenza. Il caso della J.B. Sires y Cia. (1770-1810)*, Rosenberg & Sellier, Torino 2015, pp. 77-79; M. Vicente, *Artisans and work in a Barcelona cotton factory (1770-1816)*, «International Review of Social History», 45 (2000), pp. 1-23.

[16] Biblioteca de Catalunya (thereafter BC), *Fons Barò de Castellet*, 82/3; M. Vicente, *Clothing the Spanish Empire. Families and the Calico trade in the Early Modern Atlantic World*, Palgrave Macmillan, New York 2006, pp. 43-44.

[17] P. Molas Ribalta, *Las primeras etapas de la burguesia industrial catalana*, in *Las individualidades en la historia*, II, *Conversaciones Internacionales de Historia*, Navarra 1985, pp. 223-233; BC, *Fons Barò de Castellet*, 82/3.

[18] AHCB, *Fons Comercial*, B 228.

[19] O. Raveux, A. Sanchez, *La adaptacion tecnologica como factor de localización industrial. Una revision de las investigaciones sobre la industria de hilados de algodón en Cataluña (1772-1885)*, «Investigaciones de Historia Economica», 17 (2010), pp. 65-94.

ISSN 1824-5064

workers subcontracted for semi-manufactured items or in lesser value transactions. The *fabrica de indianas* (manufacture of printed calicoes) seems to completely overturn this pattern by presenting itself as a place of production in which the organization of work is essentially centralized and based on the specialization of production stages and on internal logistics, in a context of free bargaining for the labour production factor, characterized by a renewed relationship between man and work[20]. Nevertheless, in the mid-eighteenth century, the total number of Barcelona *indianas* industry workers was not so high as to talk of a massive expansion of the factory system. It is estimated that there were about 10,000 workers in the city, whereas in the inland areas of the Principality of Cataluña, textile manufacturing was still based on a proto-industrial model. However, it is true that such a transformation, in a few decades, permanently influenced the entire secondary sector[21].

The structure of work within the J.B. Sires' factory, similar to all factories of Barcelona, was based on an organization headed by the manufacturer (*fabricante*). The manufacturer was frequently the owner (or one of the owners of the factory) and had his origins in manufacturing craft[22]. Juan Baptista Sires, in fact, had had significant experience as a manufacturing and trading *droguero*, a producer and seller of dyeing products, experience invested in the factory. Another example is provided by the manufacture of Llorens & Sevilla (which will become the most famous manufacture of Isidre Català), for which the members decided to appoint Bernat Llorens as *fabricante* and delimit his powers to the technical direction of manufacture only[23]. The work of *fabricante* would be rewarded with a monthly salary to be paid on the profits of manufacture and with the benefit of free housing within the main body of the factory[24]. Often, next to the figure of the *fabricante* – which in some ways is ahead of that of the owner

[20] R. Grau, M. Lopez, *Empresari i capitalista a la manufactura catalana del sigle XVIII. Introducciò a l'estudi de les fabriques d'indianes*, «Origens del Capitalisme, Recerques. Historia, Economia, Cultura», 4 (1974), pp. 19-57; G. Clark, *Factory discipline*, «The Journal of Economic History», 54 (1994), pp. 128-163.

[21] I. Miguel Lopez, *El censo de manufacturas de 1784. Una nueva fuente para el analisis de la industria catalana*, «Revista de Historia Economica», XIV (1996), pp. 125-181.

[22] Vicente, *Artisans and work in a Barcelona cotton factory*, p. 12.

[23] Archivo Diocesano de Barcelona (thereafter ADB), *Arxiu S.ta Maria del Mar*, Caja 68.

[24] Ibid.

 ISSN 1824-5064

of the factory, very common in those pre-capitalist models based on small and medium family-based industry – there was the *mayordomo* who had the task of supervising the proper execution of all phases of production; and who was very frequently a trusted person, often a family member, with experience in the textile industry[25].

Under these figures, the organization of the factory work was undertaken. The first line of workers was represented by the *debanadoras*; female workers in charge of unravelling spools of yarn and wrap – made by rural artisan manufacturers – stored in the warehouses of the factory. It was a task typically assigned to women for two reasons: first, it can be considered a generic and low skilled job, for this reason, during the eighteenth century, it was reserved for workers with lower skills and lower capacity to contract[26]. Furthermore, there was a technical issue related to small female hands being more suitable to perform the steps of winding the bobbins[27]. Another category of workers was constituted by the *ordidores* who were responsible for the correct positioning of the threads of cotton on the loom according to the expected number for each type of fabric. The *tejidores* took care of the production of raw canvas, working with the loom. The *peons* were, however, unskilled workers in charge of the transport of heavy operations such as linens washing and mordanting. This first level of workers was completed by *niños*, the child work force, in an intermediate position, to support the activities of weaving and dyeing[28]. Among these young workers were allegedly recruited future *pintadores* and *gravadores*; this represented a sort of training path within the factory, to learn the necessary abilities to become a skilled worker[29]. Unskilled or lower skilled workers mainly compose this first line of workers, in charge of weaving and preparing row canvas for further dyeing and printing processes. They also represent the low

[25] Ibid. In this sense, the guild apprenticeship represents the main source of skills transfers for workers. S.R. Epstein, *Craft Guilds, Apprenticeship, and Technological Change in Preindustrial Europe,* «The Journal of Economic History», 58 (1998), pp. 684-713.

[26] P. Earle, *The Female Labour Market in London in the Late Seventeenth and Early Eighteenth Centuries*, «The Economic History Review», 42 (1989), pp. 328-353.

[27] B.L. Ayala, *Condiciones de trabajo en las fabricas de indianas de Barcelona durante el ultimo tercio del siglo XVIII*, «Manuscrits. Revista de Historia Moderna», 6 (1987), pp. 121-133.

[28] J. Boy, *Diccionario téorico-práctico, historico y geografico de Comercio*, Imprenta de Valentin Torras, Barcelona 1839, p. 55.

[29] Epstein, *Craft Guilds*, p. 691.

ISSN 1824-5064

value-added production phases of the manufacture and not the core business of the firm. In fact, weaving (with spinning) was not yet mechanized and still a labour intensive activity often externalized and not integrated in the production process.

The second tier was made up of the *gravadores*, skilled workers for the preparation of the moulds to print the fabric. The moulds were made following drawings by the same *gravadores* or externally acquired. The work was completed by *pintadores* applying the mould to the rough canvas with colours. The *prat* formed the last main category of factory workers; they were unskilled but salaried workers, specialized in the operations of bleaching, drying and preparation of canvases. Such workers took their name from the *prat* (the yard to dry and expose the raw canvas to be whitened in the sun), away from the main body of the factory and located near a watercourse. The task of the *prat* workers was particularly burdensome, as they were also in charge of overseeing canvases left to dry, the reason for which they were often housed in buildings located within the same *prat*. Skilled workers mainly compose this second line of workers. Specific abilities were indeed clearer and these workers were in charge of the core business of the company.

The payroll records of J.B. Sires also reported the presence, albeit limited, of other workers such as *pinsellador* (workers involved in the «stapling» of *indianas* on racks for drying) and *debanadoras ayudandes* (associated with *debanadoras* permanently employed in order to comply with overtime loads). These kind of workers could not be precisely contextualize as unskilled, due to the fact that, in the absence of a formalized technical/professional training system, they learned the rudiments of a specific productive function[30].

In a primitive phase of work organization, prior to labour regulation, the duration and stability of work organization responded only to productive reasons. This means that the workforce level and composition was key to regulating productivity acting on the (almost) fixed costs.

The traditional discussion about Adam Smith's division of labour stresses the limitations of specialization imposed by the level of extension of the market. The empirical evidence from our case study claims that the degree of specialization is more often determined by

[30] B. De Munck, *Technologies of Learning: Apprenticeship in Antwerp Guilds from the 15th Century to the End of the Ancien Régime*, Brepols Publishers, Turnhout 2007, pp. 59-65.

 ISSN 1824-5064

other considerations. These could include the amount of general knowledge available and the costs of coordinating specialized workers within and outside the factory[31]. In this way, workers become more specialized over a smaller range of skills with a direct correlation with human capital and technological knowledge growth. We can see how an unskilled worker is less useful than a specialist in economies with more advanced technologies and an extensive human capital base, such as the Catalan cotton textile manufacture of the eighteenth century.

The presence of salaried workers in Catalan *indianas* factories introduces the problem of working time as the base parameter for salary calculation. It is difficult to establish factors for working hours in the factory. Workers in the workshop system frequently kept irregular hours, often taking Monday and even Tuesday off, working much more on Thursday or Friday. The strong control of working conditions by workers was also common in some industries still based on piece rating, such as hand-brickmaking, potteries or metal manufacturing[32].

If it is true that, by the mid-nineteenth century, discipline had triumphed in the factory textile industry, with all workers having to attend fixed hours and obey strict codes of conduct, we can observe the prelude of such organization also in Catalan *indianas* manufactures of the mid-eighteenth century. As for agricultural activities, even for manufacturing, working hours coincided with the presence of sunlight. In fact, the conventions of the eighteenth century deemed a workday duration to be about 12 hours, from dawn to noon; then, after a break of an hour or two, the work – depending on the type of it and, above all, on the owner of the factory – was continued until sunset[33]. Evidently, the working day was influenced by seasonal conditions and weather, being shorter in the winter months and on very cloudy days, conversely resulting in the longest hours during the summer sunny days[34]. In such a competitive industry as *indianas* (or textiles in general), with hundreds of factories competing to sell largely undifferentiated output in a geographically compact area, work discipline conferred a competitive advantage. The work was distributed

[31] G.S. Becker, K.M. Murphy, *The division of labor; coordination costs and knowledge*, «The Quarterly Journal of Economics», CVII (1992), pp. 1137-1160.

[32] Clark, *Factory discipline*, pp. 140-152; A. Caracausi, *Mesurer et contrôler. Les temps de l'organisation du travail dans les manufactures de laine de Padoue (XVI^e-XVII^e siècles)*, «Genèses», 4 (2011), pp. 6-26.

[33] H.J. Voth, *Time and Work in Eighteenth-Century London*, «The Journal of Economic History», 58 (1998), pp. 29-58.

[34] Boy, *Diccionario téorico-práctico*, p. 61.

ISSN 1824-5064

from Monday to Saturday, except on Sundays and holidays of religious precept, the only consideration for suspending work[35]. This trend is clear from the records of the weekly payroll of J.B. Sires & Co., which, however, emphasize that the production cycle of *indianas* was not seasonal taking place throughout the year. For this reason, the workers assigned to the *prat*, worked on numerous Sundays in order to handle the load of bleach and dry cloth ready to be printed and dyed with the start of the new week. Not all other holidays involved an interruption of the work, except for the time strictly necessary for the participation in Mass.

With factory discipline, the *fabricante* established the hours worked and workers' conduct, steadily attending to their assigned tasks. Under discipline, workers were rewarded not only according to their output, as in the workshop, but also based on their behaviour in the workplace[36]. Cotton manufacture demanded dedication to new production procedures, compliance with work schedules and tasks, close supervision and compliance for equipment that workers did not own, unlike in the guild manufacturing system[37]. Therefore, the ability to work together with other people in a closed space was necessary along with the subsequent loss of personal and direct bargaining between shopkeeper and worker, definitively the depersonalization of work[38].

The workforce

The workforce of the firm had fluctuated in size, closely linked to the production phases and exogenous factors that might influence it. The chronicles report, with a certain frequency, the halt in production of many *indianas* factories in Barcelona caused by the lack of supply of raw cotton from Maltese importers[39]. In terms of the

[35] POLLARD, *Factory Discipline in the Industrial Revolution*, p. x; AYALA, *Condiciones de trabajo*, p. 126.

[36] CLARK, *Factory discipline*, pp. 147-150.

[37] HOBSBAWM, *Labouring men*, p. 259; D.A. GALBI, *Child Labor and the Division of Labor in the Early English Cotton Mills*, «Journal of Population Economics», 10 (1997), pp. 357-375.

[38] D.S. LANDES, *The fable of the dead horse or, The industrial revolution revisited*, in *The British industrial revolution: an economic perspective*, ed. by J. Mokyr, Westview Press, Oxford 1993, pp. 128-159.

[39] F. TORRELLA NIUBÓ, *El moderno resurgir textil de Barcelona (siglos XVIII y XIX)*, Cámara Oficial de la Industria, Barcelona 1961, p. 157.

 ISSN 1824-5064

workforce employed, and given the Catalan context, J.B. Sires & Co. was an average large business in the sector, taking into account that in 1739 the Serra & Co. manufacture, with royal patronage, boasted 48 looms and 117 workers, while in 1746 the great factory of Sebastià Canals of Barcelona counted as many as 300 workers with 100 looms[40]. Almost all Barcelona's *indianas* manufactures – and this was common to most European countries – were located within the city walls, so with little space available and this was, originally, a «dimension constraint». In 1760, the Swiss factories of *toiles peintes* of Neuchâtel employed, on average, 47 workers, while in Geneva the average went up to 235. In the same year, in Mulhouse, in Alsace, the average number of workers employed was 267. In contrast, the Swiss factory of Jean Rodolphe Wetter employed about 600 workers in 1762. While the big factory of Oberkampf in Jouy-en-Josas, in 1790, employed almost 900 workers specialized in printing and dyeing[41].

Workers differentiation by gender and age is one of the main themes of the historiography on industrial development. Moreover, the question of the division of labour was already highlighted by Adam Smith as a central element of the modernization of the economy. In this sense, the expansion of the factory system had also led to a segmentation of the labour market, which had all the characteristics of the new system compared to the manufacturing handicraft corporative or proto-industrial complex.

In *indianas* production, the work force was divided vertically into three broad categories: male, child and female, according to a scheme widely used until recent times. Of particular interest is the size of these categories; specifically female employment was constituted by *debanadoras* who, as seen, formed the bottom of the production phase. It was, essentially, an unskilled workforce, so much so that this function, in the course of the life of J.B. Sires & Co., will be outsourced at a time when the company preferred to focus only on high value-added functions. The second category of workers was made up of the *niños*, child workers with an average age between 7 and 15 years.

[40] Vicente, *Clothing the Spanish Empire*, pp. 47-48.

[41] S. Chassagne, A. Dewerpe, Y. Gaulupeau, *Les ouvriers de la manufacture de toiles imprimées d'Oberkampf à Jouy-en-Josas (1760-1815)*, «Le movement social», themed issue *Naissance de la Classe ouvrière*, 97 (1976), pp. 39-88.

ISSN 1824-5064

Table 1 – *J.B. Sires y Cia. Female and child workers (percentage on total) 1779-1798*

Year	% female workers	% child workers	% Male workers	Female and child workers on total workers
1779	22%	15%	63%	37%
1780	22%	16%	62%	38%
1782	19%	21%	60%	40%
1784	20%	18%	62%	38%
1787	21%	18%	61%	39%
1792	8%	20%	72%	28%
1794	n.p.	36%	64%	36%
1798	n.p.	36%	64%	36%

Source: Elaboration on data AHCB, *Fons Comercial*, B 241 (1779), B 242 (1780), B 244 (1782), B 246 (1784), B 250 (1787), B 253 (1792), B 256 (1794), B 258 (1798).

According to data reported by J.K.J. Thomson, employment within Barcelona's manufactures of *indianas* was divided between about 55% men, 25% children and 20% women[42]. This figure, according to the British scholar, was somewhat stable within the industrial sector, and the results of J.B. Sires & Co., as can be seen from the table above, corroborate the claim. It is interesting to note that the number of female workers remained stable for about a decade until mid 1790s, when it drastically reduced and then disappeared because of a reorganization of the productive phases[43]. What is clear in our case study is that the numbers of female workers were reduced and their work outsourced at a certain point (due to the fact that their labour was mainly unskilled and related to a labour intensive production phase) in favour of child workers who were needed to carry out the most value-added production phases (dyeing and printing). This work organization seems to respond to the necessity to manage costs.

Claudia Goldin has explored the hypothesis that the proportion of women employed in the factory could affect the method of pay[44]. She compared two payment systems: the piece rate system and time rate

[42] J.K.J. Thomson, *A distinctive Industrialization: cotton in Barcelona, 1728-1832*, Cambridge University Press, Cambridge 1992, pp. 157-158.

[43] G.L. Gullikson, *Love and power in the proto-industrial family*, in *Markets and manufacture in early industrial Europe*, ed. by M. Berg, Routledge, London 1991, pp. 205-226.

[44] C. Goldin, *Monitoring Costs and Occupational Segregation by Sex*, «Journal of Labor Economics», 4 (1986), pp. 1-27.

 ISSN 1824-5064

system, in which a better performance and further efforts are compensated through the future upgrade of the worker. In such case, a less careful – and of course, less expensive – monitoring system is used. The thesis put forward by Goldin is that workers who do not plan a long-term attachment to the factory prefer the piece rate system. The consequence is that female workers prefer piece rate payment due to the fact that they are not interested in a career within the factory, while male workers, on the contrary, prefer a stable rate payment system[45].

Otherwise, child labour presents an upward trend in the period observed, with the exception of two low points reached in the years 1784-1787, probably as the firm's response to economic difficulties. The fact that child labour does not suffer a drastic reduction, as was the case for females, makes more explicit the different roles exercised within the factory. The negative correlation between the two variables also reveals the difficulties of mobility between different categories of workers. In essence, women workers responded, from the point of view of the entrepreneur, to a work demand with different characteristics. In a model with a constant technology rate, modifying the number of workers became the principal lever to act on productivity. Finally, it should be borne in mind that child and female labour as well as being the answer to a specific question of cheap labour and extremely flexible in the industrial era, was the indispensable apprenticeship, in the absence of formalized technical education[46].

Graph 1 – *J.B. Sires y Cia overall workforce trend*

Source: elaboration on data AHCB, *Fons Comercial*, B 241 (1779), B 242 (1780), B 244 (1782), B 246 (1784), B 250 (1787), B 253 (1792), B 256 (1794), B 258 (1798), B 260 (1800).

[45] Ibid.

[46] Galbi, *Child Labor and the Division of Labor*, p. 361; De Munck, *Technologies of Learning*, pp. 2-3.

The overall employment data of J.B. Sires & Co. shown in the graph above give us a situation of a growing workforce between 1782 and 1784. It then goes on to average 111 employees in 1779 to about 104 in 1782, to reach the highest number of other workers (137) in 1784, before declining in global terms to about 66 workers employed in 1800. The trend seems to be related to the firm's restructuring policy, stimulated by endogenous pressure on the national *indianas* market. The decline in the number of employed unskilled workers such as *debanadoras*, *tejedores* and *ordidores,* which even disappear in the 1794 accounting books, could be explained by the outsourcing of low value-added production phases (unwinding, warping and weaving). On the other hand, the company continues to invest in higher value-added production phases such as printing and dying/colouring. Finally, there was a strengthening in the firm's core business, carrying out dyeing and printing processes on one side, and outsourcing spinning and weaving to external producers on the other. This organization still reproduces a proto-industrial manufacturing model based on the spatial distribution of production phases. The reason is given by the focus on high value-added production phases (printing and dyeing), which allowed the possibility to use a low quality or not yet standardized cotton fabric. It could be possible due to a still active «cottage industry» specialized in cotton spinning and weaving. Cottage based spinning and weaving was even competitive in comparison to not yet mechanized internal production. At this stage of development, the mechanization of spinning and weaving was still not favourable; a human workforce was cheaper than machines[47].

Work and salary differentiation

The other main workforce differentiation within the company was based on skills. The differentiation was represented by salary differentiation and structure based on an actually not so clear distinction between skilled, low skilled and unskilled workers[48]. The low skilled

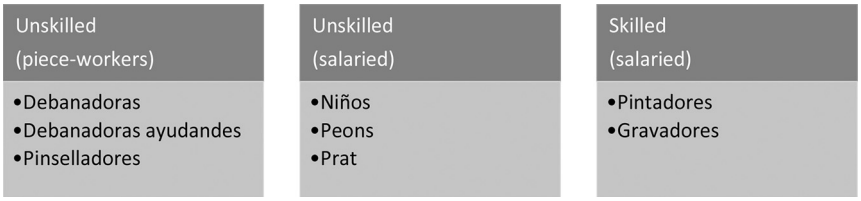
[47] D. Acemoglu, *Factor Prices and Technical Change: From Induced Innovations to Recent Debates*, in *Knowledge, Information and Expectations in Modern Macroeconomics: In Honor of Edmund Phelps*, ed. by P. Aghion et al., Princeton University Press, Princeton 2003, pp. 464-491.

[48] L. Mocarelli, *What is wrong with the history of wages. A reappraisal suggested by the Eighteenth century Milan*, in *Seven Centuries of Unreal Wages: The*

 ISSN 1824-5064

workers (*debanadoras*) and *debanadoras ayudandes* were piece-workers, paid on quantity produced. Despite not being really skilled workers – their work was mainly hard manual aimed at moving goods and loads within the factory and of course not measurable in terms of quality – *peons, prat* and *niños* were salaried on the basis of days worked per week. Finally, the skilled workers (*gravadores* and *pintadores,*) were salaried workers, paid for the time spent working in the factory.

Figure 2 – *J.B. Sires y Cia. Labour skills and salary structure*



Salary differentiation represents the other key element of the analysis of the J.B. Sires factory organization. The reason why some workers are paid piece rates based on produced output while others are salaried is often centred on monitoring costs. Usually, when output measuring is costly – this is the case of a finished product as a well-coloured and printed *indianas* – the workers will be salaried. While, if monitoring costs are low, piece-rate payment is adopted[49]. This statement is partially supported by accounting data by firm that supply precise information about the quantity produced both by unskilled/piece-workers and skilled/salaried workers. But it does not give us more information about the work and worker quality that is at the basis of the salaried work system. If we analyse the piece-workers employed by J.B. Sires & Co., we can confirm that they are employed in the low value-added production phases and respect three conditions: a) output measurement costs are very low (yarned and weaved cotton); b) at a fixed technology level, salaried workers will

Unreliable Data, Sources, and Methods that have been used for Measuring Living Standards in the Past, ed. by J. Hatcher and J. Stephenson, Palgrave Macmillan, London, forthcoming.

[49] E.P. Lazear, *Salaries and Piece Rates*, «Journal of Business», 59 (1986), pp. 405-431.

ISSN 1824-5064

produce the same output as piece-workers; c) all piece-workers are heterogeneous in ability. These conditions make piece working more convenient for the firm in the first production phases. But the payment system is more convenient for the workers too, that only have to bargain about payment for produced piece[50]. On the other hand, we have an asymmetric information context. Skilled workers (*pintadores* and *gravadores*) know their abilities and the firm does not. Furthermore, capital, especially fixed, is an important factor of production – despite *indianas* production still being a labour intensive manufacture – and it increases the value of skilled workers. So the firm will be disposed to pay a salary[51].

Table 2 – *J.B. Sires & Co. Average daily wage (in Catalan solds and dinars)*

Position/Year	1779	1780	1782	1784	1787	1792	1794	1798	1800
Debanadoras	3,80	3,40	3,11	3,35	3,22	4,50	n.p.	n.p.	n.p.
Ordidores	17,11	17,40	12,80	17,19	25,28	9,18	n.p.	n.p.	n.p.
Tejidores	9,10	9,70	10,10	10,64	9,82	11,41	n.p.	n.p.	n.p.
Pintadores	6,80	6,40	7,50	11,32	12,46	13,84	14,79	14,27	14,10
Gravadores	9,10	13,90	16,11	8,58	12,69	12,11	11,95	12,85	12,75
Niños	1,40	1,50	1,60	3,23	3,01	2,96	2,93	3,11	2,90
Prat	5,00	5,10	5,80	6,34	9,35	13,65	15,70	13,79	13,70

Source: elaboration on data AHCB, *Fons Comercial*, B 241 (1779), B 242 (1780), B 244 (1782), B 246 (1784), B 250 (1787), B 253 (1792), B 256 (1794), B 258 (1798), B 260 (1800).

Usually there were about 300 working days a year, given Sundays and religious feast-days, so the average wages were calculated on these facts. We can verify a pay differentiation applied to the female workforce, paid on the basis of quantity and quality of production, with average pays lower than those of their male colleagues. An analysis of the cost of coordinating specialized tasks and functions provides insights into many aspects of the organization of firms and industries. The fiscal accounts of the J.B. Sires company reported that the *debanadoras* are mainly piece-workers, paid on the amount of yarn pre-

[50] J. Mokyr, *The Industrial Revolution and the New Economic History*, in *The Economics of the Industrial Revolution*, ed. by J. Mokyr, Routledge, London 1985, pp. 28-29.

[51] E. Seiler, *Piece rate vs. time rate: the effect of incentives on earnings*, «Review of Economics and Statistics», 66 (1984), pp. 363-375.

 ISSN 1824-5064

pared for weaving and by its qualitative characteristics. In this sense, there may be a pay differentiation within the category, between the most experienced workers – capable of producing larger quantities of yarn prepared for higher quality – and those with less experience. The rules of the firm govern the skilled workers who are employed by the firm, whereas the activities of other piece workers are coordinated by contracts or other agreements that govern transactions across firms. The costs necessary to coordinate skilled workers differ greatly among sectors; for example, costs are relatively low in dense urban communities, and in industries where suppliers and downstream firms locate near to each other and communicate easily. The Catalan *indianas* manufacture represents a typical case in this sense with close relationships and proximity among raw material (raw cotton, dyestuff, etc.) suppliers and manufacturers[52].

Definitively, within the factory, the reason to choose or not a piece rate payment system is related to the nature of the work and the workers' ability. Let's consider, for example, two different piece rate systems; in the first one the work supply is quite heterogeneous and the firm will pay a piece rate to obtain more information about the workers' ability (asymmetric information). In this case, due to the fact that there is no obligation between workers and firm, commitments to fixing rates do not occur. So firms will try to lower rates of pay and workers will react by reducing production and increasing staff turnover; the equilibrium will be found when piece rates match the workers' best alternative[53]. In this scenario – that could fit with the reported case – the technological change will be the response of the management of the factory to workers' instability. In the second piece rate system, the work supply is more homogeneous and there is not a great ability variation among workers; in this way, firms have more complete information about workers' skills. The enterprise will pay a piece rate and invest in technology to increase productivity. In this case, the piece rate acts as an incentive for workers who will gain from the increased productivity[54].

Graph 2 shows us two main characteristics on salary differentiation within the J.B. Sires firm. First and foremost, the trend of un-

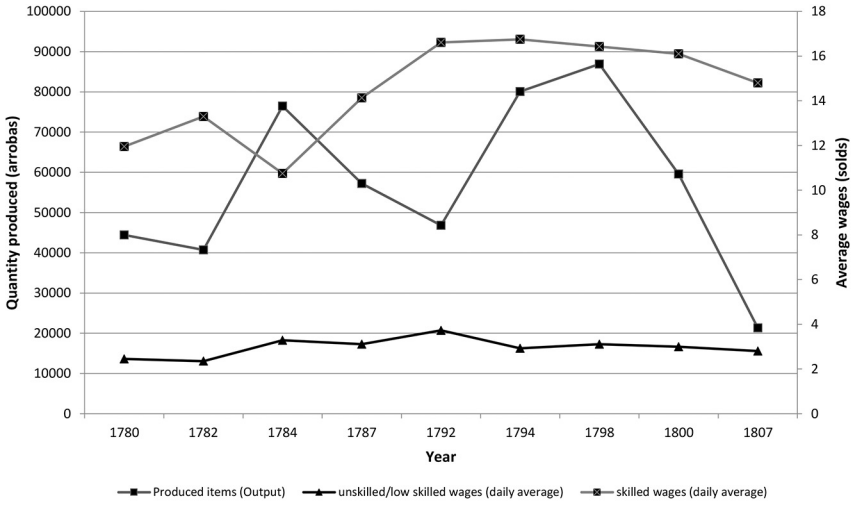
[52] Becker, Murphy, *The division of labor*, pp. 1137-1160.

[53] M. Huberman, *Piece Rates Reconsidered: The Case of Cotton*, «The Journal of Interdisciplinary History», 26 (1996), pp. 393-417.

[54] Ibid.

ISSN 1824-5064

Graph 2 – *J.B. Sires & Co. wages and production trends 1780-1807*



Source: elaboration on data AHCB, *Fons Comercial*, B 241 (1779); B 242 (1780); B 244 (1782); B 246 (1784); B 250 (1787); B 253 (1792); B 256 (1794); B 258 (1798); B 260 (1800); data for 1807 are based on a linear regression model.

skilled salaries remains almost constant in a 20-year period. As is evident, the trend is not affected by exogenous pressure or by changes in the firm's production level. While, skilled salaries are found to be more dynamic with an increasing trend that is directly correlated with company market performances. Skilled workers become more and more important for the company, especially after re-organization in the early 1790s and the implementation of high value-added production phases (dyeing and printing).

The measurement of productivity factors

In economics, productivity is the measure of output per unit of input (essentially labour and capital) and is the result of a quantities ratio. The calculation is quite easy if the producer uses a single input to produce a single output. In the more likely event that the producer uses several inputs to produce several outputs, evidently the operation is more complicated and both numerator and denominator

 ISSN 1824-5064

must be aggregated[55]. While the idea of measuring a ratio may appear easy to use, the problem of factors calculation and aggregation in complex economies has always affected these measures as reported by Abramovitz and Solow[56]. The reported case presented a simple inputs/output based model. The scarcity of fixed capital and the technology constraint along with labour intensive production give the possibility of attempting to measure the productivity of the inputs involved in production (capital, raw materials, work, production costs). The analysis of work productivity linked to firm performance and wage policy is a well discussed topic. The study of industrial relations since the 1970s has highlighted the closer relationship between labour productivity in order to stabilize unit labour costs and prices, with a deep impact on wage bargaining[57]. The use of the number of employed workers is a result of the difficulty to have a consistent number of worked days. In fact, the registration and measure of worked time was only adopted for salaried workers but not for piece-workers. For this reason, I would have had difficulty comparing non-homogeneous categories. The measure of work productivity based on the number of workers rather than the more precise index of worked time has already been used in the textile industry, especially for developing countries in order to analyse the development pattern[58]. While some studies are devoted to measuring work productivity especially under pressure of new technology or new work organization[59]. In the

[55] Z. Griliches, *The Discovery of the Residual: A Historical Note*, «Journal of Economic Literature», 34 (1996), pp. 1324-1330.

[56] M. Abramovitz, *Resource and Output Trends in the United States Since 1870*, «American Economic Review», 46 1956), pp. 5-23; and especially R.M. Solow, *Technical Change and the Aggregate Production Function*, «Review of Economics and Statistics», 39 (1957), pp. 312-320.

[57] C.S. Maier, *The Politics of Productivity: Foundations of International Economic Policy after World War II*, «International Organization», 31 (1977), pp. 607-633; S. Milner, *The Problem of Productivity: Inflation and Collective Bargaining after World War II*, «Business History Review», 92 (2018), pp. 227-250.

[58] M.S. Subramanian, *Productivity Growth in Cotton Textile Industry in Tamil Nadu*, «Indian Journal of Industrial Relations», 27 (1992), pp. 383-395; A. Razo, S. Haber, *The Rate of Growth of Productivity in Mexico, 1850-1933. Evidence from the Cotton Textile Industry*, «Journal of Latin American Studies», 30 (1998), pp. 481-517. A more fitting analysis is conducted by Jordi Domenech for the Catalan textile industry in the first decade of XX Century, studying the way workers and firms behaved in a highly cyclical sector, J. Domenech, *Labour Market Adjustment a Hundred Years Ago: The Case of the Catalan Textile Industry, 1880-1913*, «The Economic History Review», 61 (2008), pp. 1-25.

[59] S. Bowden, D. M. Higgins, *Productivity on the Cheap? The 'More Looms'*

following calculation, an average productivity measure has been adopted as a proxy of partial productivity of the inputs[60]. The only available data about inputs is given by the costs, so we can consider, at constant prices, the production costs as proxy of inputs quantity. For these reasons, the productivity measure will not be an effective benchmark of firm performance, rather an approximation, a rough trend of the productivity in J.B. Sires & Co. It could be considered a first attempt to measure the economic performance index with an incomplete data set.

Considering the hypothesis of a linear production function in the short term where:

$$Y = f(K, L)$$

The average productivity is calculated (at constant factors price) by the formula:

$$Pa = \frac{Y}{L}$$

where Pa is average productivity, Y is the yearly produced quantity and L is the yearly quantity of all the factors of production (work, capital, raw materials, etc.).

While the work productivity is calculated by the formula:

$$Pw = \frac{Y}{W}$$

where Pw is the average work productivity, Y is the yearly produced quantity and W is the yearly quantity of work measured in terms of employed workers.

Graph 3 shows clearly the correlation between work productivity (both skilled and unskilled) and output. The possible explanation lies in the nature of the calico production that was mainly a labour in-

Experiment and the Lancashire Weaving Industry during the Inter-War Years, «Business History», 41 (1999), pp. 21-41; J.M. Wilson, A. McKinlay, *Rethinking the assembly line: Organisation, performance and productivity in Ford Motor Company, c. 1908-27*, «Business History», 52 (2010), pp. 760-778. There are numerous studies about sector productivity performance, just as a limited example see: A. Godley, *The Development of the UK Clothing Industry, 1850-1950: Output and Productivity Growth*, «Business History», 37 (1995), pp. 46-63.

[60] V. Mariappan, K. Chidambaram, *Public Sector Textile Mills: Productivity Performance*, «Economic and Political Weekly», 38 (2003), pp. 1551-1554.

 ISSN 1824-5064

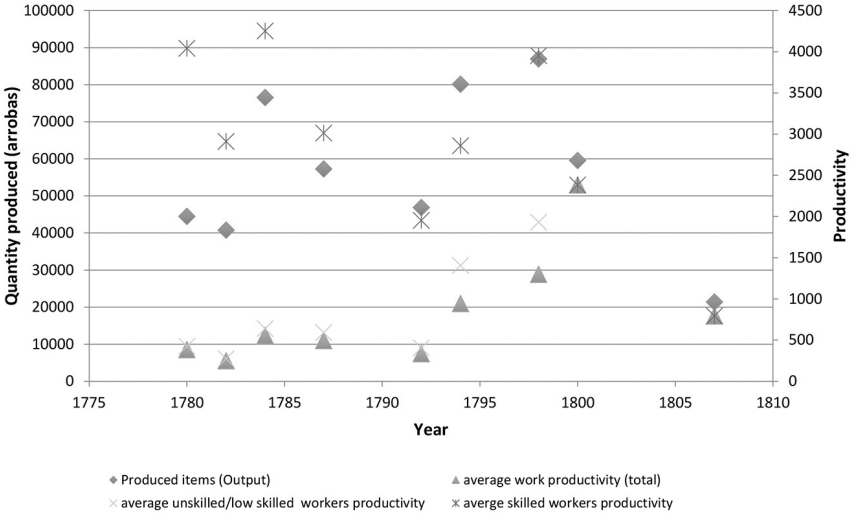
Table 3 – *J.B. Sires & Co. production, wages and productivity (1780-1807)*

year	produced items (Output in *arrobas*)	total production costs (Input in Catalan *solds*)	Productivity O/I	Workers (Total)	Workers (unskilled)	Workers (skilled)	average work productivity (total in *arrobas*)	average unskilled workers productivity (*in arrobas*)	averge skilled workers productivity (*in arrobas*)
1780	44.445	44.341	1,00	116	105	11	383,14	423,28	4.040,45
1782	40.742	70.596	0,57	164	150	14	248,42	271,61	2.910,14
1784	76.490	80.788	0,94	138	120	18	554,27	637,41	4.249,44
1787	57.234	76.232	0,75	116	97	19	493,39	590,04	3.012,33
1792	46.817	66.946	0,69	140	116	24	334,40	403,59	1.950,70
1794	80.081	145.220	0,55	85	57	28	942,13	1404,93	2.860,03
1798	86.924	100.203	0,86	67	45	22	1.297,37	1931,65	3.951,11
1800	59.550	95.303	0,62	25	0	25	2382	n.p.	2.382
1807	21.352	112.280	0,19	27	0	27	790,81	n.p.	790,81

Source: elaboration on data AHCB, *Fons Comercial*, B 241 (1779), B 242 (1780), B 244 (1782), B 246 (1784), B 250 (1787), B 253 (1792), B 256 (1794), B 258 (1798), B 260 (1800), data for 1807 are based on a linear regression model.

ISSN 1824-5064

Graph 3 – *J.B. Sires & Co. Output and productivity trends 1775-1810*



Source: elaboration on data AHCB, *Fons Comercial*, B 241 (1779), B 242 (1780), B 244 (1782), B 246 (1784), B 250 (1787), B 253 (1792), B 256 (1794), B 258 (1798), B 260 (1800), data for 1807 are based on a linear regression model.

tensive manufacture. The idea that in the long run the wage rate and produced output should be a highly desirable match is present in the scientific literature as a positive index of enterprise performance[61]. Meanwhile, short-term fluctuations in wages and productivity have effects on costs, prices and profits. It is not always easy to identify the factors that lead to a divergence between average production and work productivity. In a first attempt to give an explanation for such phenomena, it would be important to analyse enterprise structure and possible changes in its factors of production ratio. The classical literature usually indicates six determinants in the output/wage ratio:

1) The level of skilled workers and their effort is usually affected by a fast turnover and recruitment of marginal workers. The performance could be affected by informal practices of unorganized workers' groups (working conditions, incentives, punishment);

[61] C. KERR, *The Short-Run Behavior of Physical Productivity and Average Hourly Earnings*, «Review of Economics and Statistics», 31 (1949), pp. 299-309.

 ISSN 1824-5064

2) The contribution of management is a factor influenced by abilities and experience and could be improved by the use of cost accounting tools;
3) The level of technology is usually a key element in determining the productivity;
4) The regularity of the flow and the quality of raw materials;
5) The variety, quality and variability of products;
6) The level of capacities affect the proportion of fixed workers necessary to maintain the operations compared to variable workers[62].

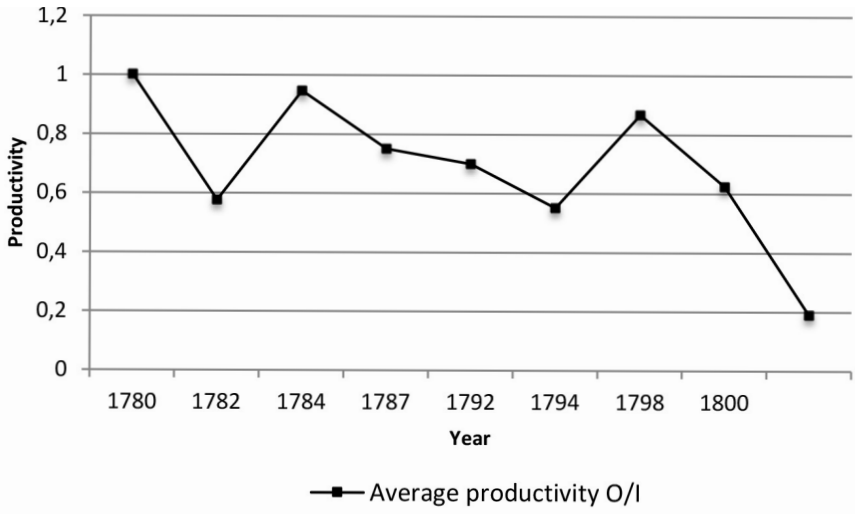
Following the previous points, it is possible to attempt a twofold level explanation for the decrease in productivity. At micro level: 1) It is an option that a fast turn-over of skilled workers led the firm to recruit marginal (and less efficient) ones; 2) The development and adoption of a management accounting system, although in embryo, does indicate an enhancement of management ability; 3) The studied period is characterized by a substantial stability in production technology. This is confirmed by the low level of fixed capital and the complete absence of new machines in the Barcelona calico printers' inventories of the period; 4) Periods of scarcity of raw or semi-finished cotton are well documented by archival sources, this could affect the production output of the firm; 5) The variety and quality of production represent a pivotal topic because the J.B. Sires & Co. documentation reports a continuity of production in terms of variety but it is very hard to understand a possible modification in terms of quality; 6) The last point seems to fit precisely with the represented case. In fact, J.B. Sires & Co reduced its workers in the last decade of the eighteenth century, only retaining the skilled workers and concentrating production on the value-added phases (dyeing and printing).

At a macro level, it is possible to attempt a further clarification of the decrease in productivity with fairly solid reasons, to specific cyclical evidence. The War of the Fourth Coalition in which France fought against Great Britain and, soon after, the French invasion of Spain under Napoleon in 1808, could be considered an abrupt interruption of the positive economic cycle. These two events led to a contraction of the domestic market and a drastic reduction of access to the colonial market (both for raw cotton imports and finished calicoes exports). Furthermore, the calicoes domestic market was hit by the growing smuggling of British products.

[62] Ibid., p. 302; W. Bowden, *Wages Hours and Productivity of Industrial Labor, 1909 to 1939*, «Monthly Labor Review», 51 (1940), pp. 517-544.

ISSN 1824-5064

Graph 4 – *J.B. Sires & Co. average productivity 1780-1800*



Conclusions

Definitively, the empirical data show how the transformation of the firm, implementing bleaching, dyeing and printing contributed to stabilize the company's profit. Nevertheless, the statistical test on the data set demonstrates how J.B. Sires & Co.'s profits are correlated both with skilled and unskilled workers. It means that *indianas* production is still based on labour intensive procedures while the technology/skill content is limited. Furthermore, there is evidence that the piece rate system is the most appropriate for *indianas* production due to the fact that the labour supply is quite heterogeneous with an asymmetric information for the firm about its characteristics. Piece rate payment is the only way for the firm to obtain more information about work quality and consequently reduce payments[63]. The elimination of the low value-added production phases could be the firm's response to an abrupt inversion in the business cycle, probably caused by exogenous events. However, some data indicate that – apart from the overall reduction in workers – the firm modified its behaviour about workers turnover, probably recruiting marginal workers, and

[63] HUBERMAN, *Industrial Relations and the Industrial Revolution*, pp. 360-363.

 ISSN 1824-5064

so negatively influencing productivity. While a major topic about the effective quality of the manufacture, as an important element of productivity, still remains unsolved for the difficulties in checking the exact quality of J.B. Sires' products. One of the main limitations of the present study is constituted by the one firm only model, which does not permit an overview of the sector. Increasing the data related to firms operating in the sector will entail the possibility of creating a multi-entries model that could better describe the entire industrial sector.

The factory model too is a work in progress, with enough modernized managerial and organizational aspects working together with some typical proto-industrial characteristics (piece-workers, low technology ratio and labour intensive productions). We are in the midst of a deep transformation of manufacturing, from an artisan system of production to a factory model that is widespread in the textile sector[64].

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[64] A. Guenzi, *Cutlery trade. Le origini corporative dei distretti industriali in Europa (secoli XV-XX)*, Rosenberg & Sellier, Torino 2014, pp. 225-228.

ISSN 1824-5064