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Technological and corporate innovation in the Spanish specialised metallurgy: the case of Rivièrè (1860-1924)

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ABSTRACT

Metallurgy is together with textiles the leading industry of the first industrial revolution in Spain, a feature highlighted by the literature from very early on. One of its sub-sectors, this of metal transformation, has received very special attention from researchers. However, certain gaps still persist in some branches especially those relating to various factors of the production system at the factory level, such as capital –equipment and energy-, labour and corporate structure. Herein lies the main motivation of this research, which addresses the reasons for the success of medium-sized companies in specialised metallurgy in the late 19th and early 20th century, using a case study methodology, primary sources and the comparative procedure. The text is made up by three main sections, comprising the formation of the Rivièrè company, the production system of this company and its organisational innovation.

KEYWORDS: Rivièrè, Technological innovation, Corporate innovation, specialised metallurgy

JEL CODES: N00, N1, N64, O33, F23

1. Introduction

Textiles and metallurgy led the first industrial revolution in Spain in two regions - Catalonia and the Basque Country - that brought Spain into the great European transformation. Vicens Vives alluded to this binomial of expansion of the textile industry and a rise of metallurgy, the latter still unpromising in the second half of the 19th century. This author completed his synthetic vision with a broad temporal scope, which began with the first industrialisation efforts in the 18th century, the weakening after the War of Independence, the slight recovery (1827-1834) and the effort to find a solid industrial structure through modern equipment and capitalist concentration in the cotton industry (1834-1854)¹.

The characteristics of the metallurgy in Catalonia was marked to a large extent by its development in Barcelona and was strongly conditioned by the disadvantage of the remoteness from the major iron and steel centres, a differentiating factor that began to

¹ *Vicens Vives* (1959).

appear at the end of the 19th century with respect to the Basque Country, better endowed in iron and steel².

The city enjoyed locational and transport costs advantages, together with the external economies generated by its size and its dual seaport and industrial nature. No less important is its position as a hub with a strong institutional framework, in which the Junta de Comercio (Board of Trade) stood out through jurisdiction over the whole of the Principality of Catalonia. This institution ruled Catalan commercial and industrial activity in 1758-1876 with a special emphasis on demanding a protectionist policy from the State. The list of perks grows longer with Barcelona's easy access to technology and knowledge transfer flows in Europe, sometimes as a point of arrival of immigrants, in particular French³.

Three are the types of external economies driving spatial agglomeration: a shared skilled labour market, proximity of customers and suppliers, as well as quick and relatively cheap access to specific knowledge and information⁴. In the definition of Barcelona's harbour system, France (Marseilles), as well as Italy (Genoa), play an important role: both are the main suppliers of foodstuffs, raw materials, machinery and technical know-how for Barcelona⁵.

In its general features, the iron and steel industry in Catalonia has been covered in reference works and individual studies. In their pioneering works, Nadal and Tortella pointed out the traits of this sector and the characteristics of its take-off and early development⁶. We have also long been familiar with the trajectory of some companies, such as the emblematic Maquinista Terrestre y Marítima (MTM)⁷. In recent years, research has been carried out on major companies - Hispano-Suiza, MACOSA, and Nuevo Vulcano for instance⁸. On the one hand, it confirms the interest in the issue and, on the other, it ratifies the existence of gaps to be filled. In particular, there is still a lack of monographic studies on companies which, without the attractiveness of the large ones, are key in some sub-sectors.

This article sets out to describe and analyse a company of specialised segment of this industry, namely metal processing - wire drawing, wire mesh, wire cloth and nails - in the late 19th and early 20th century. Its structural traits define it as a capital-intensive industry with an overwhelming weight of raw materials in the production costs, as opposed to the secondary burden of labour. On the other hand, it meets a very broad demand because its products supply the various needs of the economy, i.e. agriculture, mining and industry.

² Tortella (1981); (1994), p. 83.

³ Moreu (1959). The French had solid institutions (a church) in Barcelona.

⁴ De Langen (2020) [np].

⁵ Calosci (2007), p. 15.

⁶ Nadal (1975); Tortella (1981).

⁷ Del Castillo (1955); Fernández (2004), pp. 197-213; VVAA (2009); Cayón y Muñoz (1998).

⁸ Nadal (2020); Sánchez-Carrión (2015), 111-26.

Researchers have devoted a very special attention to this sub-sector of specialised metallurgy⁹. However, certain gaps still persist, in particular those relating to various factors of the production system at the factory level, such as capital –equipment and energy-, labour and corporate structure. Herein lies the focus of this research, whose guiding thread lies on the reason(s) for success of medium-sized companies in specialised metallurgy and the mechanisms of oligopoly formation in non-core sectors, through a case study methodology, primary sources and the comparative procedure¹⁰. The main primary source comes from the Rivière Archive, which contained key information on the production process in the factories - in detail wages and working patterns-, organisational forms and technological change. Electrification, an essential feature of technological change that is generally underestimated, as well as the increase in production capacity stems from the Archivo Administrativo del Ayuntamiento de Barcelona, Industrias particulares (AAAB) [Administrative Archive of the Barcelona City Council, Particular Industries].

The article comprises three main sections devoted to the formation of the medium-sized company Rivière, its invention and innovation process and to corporate innovation, human capital and competitiveness.

It is worth noting that specialised metallurgy is closely linked to French investment and technology, a feature that distinguishes it from other experiences in southern Europe, including Italy, which is driven by very local names¹¹. In addition to this differentiating aspect, there are two further: the relationship with machinery supply chains and diversification.

In sum, specialised metallurgy had clearly contributed to the diversification of the productive fabric, a process which in the first post-war period placed Barcelona's iron and steel industry as a whole in second place (15.52%) among the city's industries, at a distance from textiles (31.23%) and ahead of chemicals (12.23%). The years 1900-1930 correspond to the period of consolidation of a real industrial structure (the Hoffman index - light industry workers/heavy industry workers- went from 4.4 to 0.9¹².

⁹ Calvo (1986); Fernández (2005), pp. 165-191; (2005a), pp. 1-22 and (2005), pp. 439-456.

¹⁰ The status of medium-sized company is given by its fixed capital (9,081,336 pesetas in the 1930s), a figure equivalent to 71.8% that of MTM around 1922, to 4.5 times that of Cía. Electrometalúrgica del Ebro and 18.6 times that of TyPC.

¹¹ The surnames (Detouche, Clausel, etc.) and names of the companies (Tréfilerie et Pointerie Catalanes) (TyPC by its acronym in Spanish) testify to this. At TyPC, founded by French FDI from Tréfileries du Ramier du Bazacle (Toulouse), management fell to human capital from the nationality of the investors, trained in the company's own establishments. This is an example of a multinational company transferring know-how to the subsidiary, which is considered conventional, through the expatriation of people, with the possible existence of technical family sagas. In comparative view, Italy shows features of both smallholding and geographical concentration in Lecco and the surrounding area, Novara, Milan, Florence and Genova: Giordano (1864), p. 181; Albo (1918-19), *passim*.

¹² Calvo (1988), p. 6. The iron and steel industry had gone from employing 4.94% of the industrial population of Barcelona to 19.4%.

Undoubtedly, one of the most prominent undertakings was Francisco Rivière, on which we will focus below.

2. The drive of innovative firms: the formation of the company Rivière

Unlike what one might think, the beginning of Francisco Rivière Bonneton's activities in Spain has nothing to do with the metal processing industry but to his employment on the Paris-Lyon-Méditerranée railway. His entry into the industry occurred in 1860, when he teamed up with his compatriot Pierre Mage, who had a background as a wire cloth producer, to open a wire cloth factory in Madrid under the name Sociedad Mage, Rivière y Cía.¹³ By the first half of the 1860s, his marriage to Matilde Chavany, owner of an establishment of haute couture and millinery, very possibly provided Rivière with liquidity and he took over the entire business, after redeeming the share of the partner's heirs. In 1875, the business upturn of the Madrid workshop, with fifteen looms installed, encouraged Francisco Rivière to attempt alone an initial expansion in a new location in Bilbao. He quickly expanded the capacity of the business in part using machinery and labour from Madrid and kept it under his constant personal supervision from Madrid and occasionally in situ. After the failure of the initiative, because of the external causes - negative impact of the Carlist War on the industry-, Rivière focused on reorganising the business in Madrid, first, and then on changing the location of his expansion projects¹⁴.

An important spur to progress were arrangements, such as the one signed in 1876 with Mourot Aîné, technician from Montrouge (Seine) for the first best-selling sheets and perforated sheets. He also opened up a long-lasting business flow with the company of the engineer Alfred Delrée (Liège) that continued for many years just as he placed orders with foreign firms¹⁵.

Benefiting from its location required a favourable placement for import trade, a requirement that the high costs of transport in Madrid did not guarantee. Francisco Rivière

¹³ Most likely, Mage was a partner in the family company Mage Frères, owner of a metalware factory in Lyon and a silk deposit: *Annuaire général du commerce, de l'industrie, de la magistrature et de l'administration*, 1847, p. 1,210. Rivière met Mage at the Madrid Agricultural Exhibition (1857), an indicator of the fruitful role of exhibitions: Rivière-Manén (1959), p. 30.

¹⁴ Matilde Chavany descended from French landowners of Lyon and Orléans: Rivière-Manén (1959), pp. 32, 259; *Le Mémorial des Pyrénées*, 28/1/1881; Cabana (2001), p. 167. After finishing his studies, François Rivière Bonneton worked as an apprentice in a weaving shop in Paris and as a draughtsman at the Strasbourg Railway Company, attracted by the expectation of a good salary: Rivière-Manén (1959), pp. 17, 23 and 26. In Spain, Rivière teamed up with three partners to carry out works for the Ferrocarril del Norte: *La Correspondencia de España*, 14/6/1862. The choice of Bilbao probably stems from its greater ease of access to Angoulême, a major centre for the paper and ancillary industries – that of Weiller, for instance- and a supplier of semi-finished metal products. After the failure in Bilbao, Rivière established a warehouse/branch in the major flour and finance centre of Valladolid to cover the supply of milling machinery, which was also to run into problems: Rivière-Manén (1959), pp. 110, 115; Alonso et al. (2019), pp. 179. The metal district of Valladolid made the most of its geographical location, the means of transport —Canal and Railways— and electricity at the beginning of the 20th century. Technology and knowledge transfer from France was also of great significance: Alonso et al. (2019), pp. 177–89. In this analysis, the absence of the role of the tariff is striking.

¹⁵ Rivière-Manén (1959), p. 103.

chose Barcelona to set up in business and fighting off his competitors¹⁶. In 1877, the year after his arrival, he opened a branch which would soon close, but it would lay the foundations for future activities in Catalonia. Thus, he tested a niche in the market with a promising product then not very popular in Spain. First he embarked on a merchant's career as a retailer of double-twisted gratings imported from the British company Boulton & Paul of Norwich. As consumption of these goods increased, Rivière bought machines to manufacture them in Barcelona. He even reinforced his bet with product innovation, namely double and triple twisted wire gratings. He extended the value chain by obtaining a patent to manufacture them, which was to cause him so much trouble with Marull¹⁷.

Thus was born the factory located in Sant Martí, the traditional area of attraction of specialised metallurgy, which also housed important companies like Materiales de Ferrocarriles y Construcciones of the Girona family and Torras, Herrería y Construcciones¹⁸.

Respectable size, cost-saving organisation and technology as well as meeting diversified demand were the cornerstones of Rivière's capacity. The figures speak for themselves: a new factory with an area of 6,000 m², nine handlooms in 1887, powered by a locally manufactured 50 hp central unit steam engine, one hundred workers on the payroll, production worth 700,000 pesetas and sales of 22,500. Committed to upgrading with modern manufacturing processes, Francisco Rivière sought to consolidate its market share through product innovation (triple-twist mesh). Then he tested in London the possibilities a continuous machine of the manufacturer Gouchdard-Massey (Nottingham). The company's products included extra-strong cloths for large mining operations, endless cloths for the manufacture of continuous paper –reinforcing the metal/paper connexion-, springless bedsteads and double-twisted galvanised gratings. This underlines the diversification of its technological links and dependence on foreign countries¹⁹.

A very important matter, the management was of family style - Francisco Rivière and his son Ferdinand-, according to the owner-managed business model, aiming to save on the agency costs of ownership.

The momentous stage of the creation of the domestic market in the early 1870s required "years of hard personal work" and fierce fight by the young founder to "consolidate his business", diversifying production and complementing it with commercial import activities, particularly in the specialty of milling machinery²⁰. In other words:

¹⁶ Rivière-Manén (1959), p. 97. Rivière referred to the fifteen-hour diligence journey Perpignan/Barcelona and his first meetings, devoted to his competitors: Rivière-Manén (1959), p. 105.

¹⁷ Rivière-Manén (1959), pp. 113, 133. Rivière and Marull accused each other of usurping the procedure: Colección legislativa (1900), pp. 06-410.

¹⁸ Nadal and Tafunell (1992), p. 161; Cabana and Feliu (1987).

¹⁹ Rivière-Manén (1959), p. 113.

²⁰ This conquest of the domestic market meant long and complicated journeys through the remote Spanish geography and nights in rural inns: Rivière-Manén (1959), pp. 124-125; 188. Francisco Rivière's catalogue included metal cloth, millstones, cleaning and sifting apparatus, manufacturer and builder: *Revista minera, metalúrgica y de ingeniería*, 30-31, 1879, p. 294.

diversification and integration. The new products were domestically made by acquiring the appropriate machinery for the new factory in Barcelona.

Francisco Rivièr e Hijos did not cease in its diversification strategy. Under the protection of an 1888 law, it applied for the temporary admission of wires of various metals for the manufacture of wire mesh, cables, springs and artificial hawthorn, among a variety of goods for export. The reasons for this were the uncompetitive price of the national product and the lack of certain products, despite having sufficient means of production. The price of domestic iron and steel wire exceeded by a wide margin that of foreign goods, a difference more severe in the annealed than in galvanised. Thicker wires (below number 13) produced domestically were cheaper. Dependence on imports of brass, copper and bronze wires added 41-64 % to the price for various reasons - exchange costs, customs duties, etc. - and made export impossible. If we look closely, the data show a smaller difference in galvanised wires with a fineness of up to fifteen tenths of one mm²¹.

The capacity-building phase was then over. By the time of the Universal Exhibition in Barcelona (1888), Rivièr e was at the forefront of a market whose consumption potential for wire cloth had increased a hundredfold since 1854, displacing firms doing business abroad. Before long, he was in contact with agents in Buenos Aires who were keen to penetrate the Latin American markets, undeterred by the end of the system of protection²².

The years 1887-1902 are considered by the family history as the second founding period, as they laid the foundations for further development from 1902 onwards, under the name of Francisco Rivièr e Hijos. Reorganisation according to a completely different concept, a change of location, the construction of a new factory, diversification of production, consolidation of the domestic market and rapid technical transformation constituted the main ingredients of the new phase.

Diversification, integration and, very importantly, again contacts as an intermediary in the network of foreign houses aspiring to gain a foothold in the Spanish market. By curiosity, the five known cases of mediation from 1903 to 1914 were established in branches quite outside Rivièr e's speciality in return for commissions and discounts. The houses involved included Dietrich Schlinder, a Zurich silk manufacturer, T. Hurdman & Sons Ltd. of Bury (Lancashire), taking advantage of Rivièr e's relationship with the paper manufacturers, P. Carelli Jr. (Saarbrücken) for conveyors and other products, L. Chevenier for grips, and Dennert & Co for cutlery trays and coin boxes. The intermediary role was extended to Spanish houses since he became the representative for the whole of Spain for

²¹ *GdM*, 26/3/1903, 85, pp. 1,304-1,306. The number of the wire indicates its thickness according to an inverse relationship (the lower the number, the finer the wire).

²² AHR, Letter Copier to F. Rivièr e. From 1879 at least, the company had warehouses and office in Madrid (*Revista minera, metalúrgica y de ingeniería*, 30-31, 1879, p. 294) and sold through commercial travelers in the home market and a network of sales agents in the foreign market by geographical areas; the direction of the sales for Europe fell successively to the founder and to his son F. L. Rivièr e Manén.

‘deployé’ metal, manufactured by the Sociedad Española de Construcciones Metálicas, with discounts and bonus on consumption²³.

From very early on, Rivièrè strove to set itself up as the exclusive manufacturer of certain products using both its own and third-party technology. In 1896, he bought six mechanical looms from Irmischer of Saalfeld (Germany) and, four years later, obtained a five-year patent for a wire crimping process²⁴.

Technology was joined by human capital as well as corporate influence and social relations. The recruitment of qualified personnel, including foreign workers for wire mesh, enabled the project to be completed. Francisco Rivièrè strengthened his presence in the sector by joining the Fomento del Trabajo Nacional (FTN), the protectionist organisation par excellence, of which he was a member of the board of directors²⁵.

At the end of the 1890s, successive marriages brought the Rivièrè family closer to dynasties representing two sectors of the country's industry, one of them - paper - vital because of its high demand for Rivièrè's speciality goods²⁶.

The list of drivers was rounded out by product and market knowledge and personal relationships with customers, a little highlighted fact that encouraged the transfer of knowledge and skills for manufacturing improvement, an essential component of capacity building in a company²⁷.

There was no lack of difficulties. The independence of the colonies meant a serious setback for exports to the West Indies and the Philippines, markets that Rivièrè then sought to recover and even expand.

The growth policy took a major leap forward when Rivièrè acquired the small wire factory that Trefilería Franco Española had in the Marina de Sants, one of the favourite areas for the indianas' meadows in the first Catalan industrialisation and a strategic point in the expansion of Barcelona²⁸. Rivièrè transformed it into a modern establishment through a gradual renovation and expansion spanning the six years before the war: pickling and furnace buildings (1907-1908), a dispatch warehouse (1911), the purchase

²³ AHR, Series s/n, Correspondence, 12 and 19/2/1903; 21/4/1908; 10/1, 26/3; 30/4/1914.

²⁴ Rivièrè-Manén (1959), p. 187.

²⁵ Indirect sources suggest a French origin of a part of the workforce: *Sentencias del Tribunal Supremo de Justicia*, 1877, p. 647. There is talk of "a staff of faithful, self-sacrificing and competent men": Rivièrè-Manén (1959), pp. 78, 92; 102-103. In 1905, a visitor was astonished that "wires and thread bars of such thickness can be worked into such a perfect fabric". The FTN had more than 2,100 members, representing a quarter of Spain's capital. Although the nucleus was in Catalonia, a good number of large manufacturers and owners from the rest of Spain belonged to this employer organisation: *La Vanguardia*, 13/2/1890, p. 3.

²⁶ Marriages with members of the Manén-Massana and Caralt-Sala (textile) and Torras (paper) families.

²⁷ Rivièrè imported wire from Europe, such as the consignment from Antwerp at the end of the 19th century: *La Publicidad*, 18/1/1898, p. 4.

²⁸ *The factory had a steam generator, six annealing ovens and a galvanising furnace. The foremost scholar on the indianas is Sánchez (2012) and (1992), pp. 213-28.*

of land from Altos Hornos de Cataluña and the Nuestra Señora del Carmen ironworks (1913) and a new warehouse (1914)²⁹.

Rivière gained a foothold in the wire and iron nails market and in the market for wire cloth, gratings and other traditional articles produced at the Sants and Sant Martí factories, respectively. In comparative terms, Francisco Rivière e Hijos paid in 1906 a total tax equivalent to 24.68% of that paid by MTM, while the percentages for Detouche and Olivella were 15.13 and 12.25%. Data show the superiority of Rivière's fixed assets compared with Metalúrgica Rosés, Rivière's rival and associate, which was less than 2.4 million pesetas. In the 1930s, the value of Rivière y Cía.'s land was 5.95 times that of Cía. Metalúrgica Rosés, buildings 3.43 times and machinery and plant 3.71 times. Finally, if we consider the installed power, we see the greater production capacity of Metalurgia Española (Table 1)³⁰.

During the WWI and in the immediate post-war period, further extensions and technical improvements were carried out, including the construction of a room for multiple wire drawing machines in 1916, a building to install the new aiming and barbed wire machines the following year, and a new room on the first floor in 1919³¹.

The critical situation of the 1920s did not seem to interrupt the investments in the Sants factory³². In 1921, this plant, which occupied 8,773 m² of ground, housed up to six buildings: a single-storey warehouse on the eastern side, two single-storey and two ground-floor buildings on the northern side, and the marksman's workshop. From 1921 to 1925, a pickling dryer, a first wire resistance testing machine, an electric testing furnace and two barbed wire machines increased the production capabilities and tools. Finally and very important, the capacity for innovation was reinforced with an R&D unit, the laboratory.

Archaeological sources, particularly plans, abound on the growth process. First of all, it is worth highlighting the search for rationality in the location close to water resources and communication routes - the Infanta canal, the MZA railway and the Can Tunis road. Thirteen years of transformations could be summarised as an enlargement of the land and buildings; a reorganisation of the old central body and a densification of built space³³.

As for the equipment, Rivière offered an increase in technical resources, in production capacity according the energy indicator. The workforce doubled in 1914 compared with

²⁹ Calvo (1986), p. 131.

³⁰ Calvo (1988), pp. 11-43

³¹ Calvo (1986), p. 131.

³² The Labour Inspectorate noted with optimism the partial overcoming of the war crisis and a notable general improvement in the industries of Catalonia, which translated into the normalisation of work because of social peace: IRS (1921), p. 65.

³³ Calvo (1986), pp. 131-32; AAAB, IP, Rivière.

ten years earlier, quintupled in 1924 and increased eightfold in 1934, in all cases by more than five times³⁴.

Of the Sant Martí factory, worst documented, we know of the increase in personnel, which almost tripled between 1888 and 1910, various improvements and the negative impact of the outbreak of the WWI on the enlargement projects of one of the warehouses³⁵.

Successive extensions, reforms, acquisitions and new machinery installations had turned the company from a small artisan unit into a complex medium-sized company without losing its family character, as the figures of its fixed capital, market share and tax show³⁶. Concerning the corporate change, on the death of the founder in 1911, his sons Francisco and Fernando Rivière Chavany took over the company, which in 1921 changed its name to Rivière y Cía.³⁷ In 1935 it officially became a public limited company as Rivière SA., and later during the Civil War it was collectivised³⁸.

2. Invention and innovation at Rivière

The time has come to analyse the key point of the innovative industrial production system in its various steps and components.

As obvious as it may seem, a close link between the above-mentioned product innovation and the use of new types of machinery, own or imported, should be noted. From 1867 to 1919, Rivière registered 2 privileges (one for introduction and one for invention), 28 patents (22 for invention, 4 for introduction and 2 certificates of addition) and 10 trade marks (6 manufacturing and one trade name, 3 without a name). It began with a privilege of introduction for the mechanical manufacture of wire gratings, which was followed by a second one several years later for a continuous mechanical sawing system called "American". In 1884-1887, at the end of the construction capacities phase, invention patents followed for the already mentioned process for the manufacture of double and triple twisted wire mesh, for product invention - various versions of wire cloth - and for mechanisms - rollers for application to continuous paper machines. The protectionist tariff of 1891 encouraged the innovation as the company registered two processes for the manufacture of artificial hawthorn and woven wire clothes .

In the early years of the 20th century, invention patents involved innovation in equipment - manufacture of metal fabrics by means of special shuttles (1902), a system for joining fabrics (1903) and special loom for weaving with crimped wires (1904) - and in product - metal cables or cords (1903) and multi-twisted wire mesh (1915) .

³⁴ Calvo (1986), pp. 131-32; AAAB, IP, Rivière.

³⁵ Calvo (1986), pp. 133-134; AAAB, IP, Rivière.

³⁶ *AFySAdE*, 1920, p. 549; *Revista nacional de economía*, 1, 1916, p. 68 The Rivière family had a practice of hoarding wealth; the authorities confiscated 200 kg of silver objects and jewellery for personal use during the Civil War.

³⁷ Calvo (1988), p. 31.

³⁸ Archivo del Banco de España, Sucursales, Barcelona. Carme Vega dates the approval of the Statutes of Trefilería Barcelonesa at the Assembly of 3 October 1936.

We know that Rivièrè turned product differentiation and quality into a tool for conquering the market. He manufactured two main types of products - wire and nails - in separate factories within Barcelona, to which were added a wide range of goods. The Sants factory produced 876,554 kg composed by a third of pickling, 30 % wire, 22.47 % furnaces and 14.23 % galvanised goods . The unit cost structure varied within the same type of fabrics, depending on the quality. We are dealing with a capital-intensive industry with a very low labour share in costs between 2.8 and 5.9 % of the total. The comparison with other companies ratifies this characteristic as a feature of the sector, which, on the other hand, did not prevent attempts to achieve competitiveness through the reduction of workforce costs .

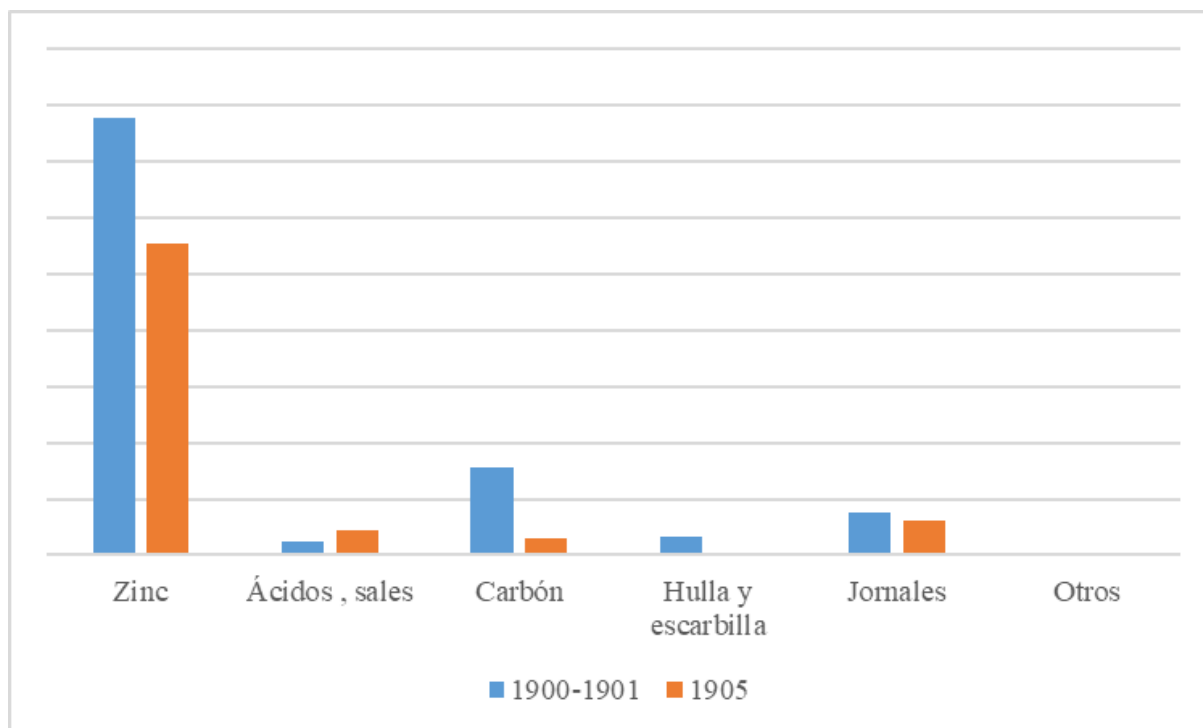
From the beginning of the 20th century, Rivièrè achieved something that the textile manufacturers, after many years of trying, were still far from achieving: to produce at prices competitive with those abroad. This is acknowledged in a 1901 document, which establishes a difference of 125.93 ptas./t on the prices set by Felton at any port in Spain. In general, Rivièrè reached competitiveness with foreign products in a context of inadequate protection for this industry, as for all industrial manufacturing activities using iron and brass as raw materials .

The records in the family archive allow us to compare two relatively close moments of the two factories. Graph 1 shows the evolution of the production of galvanised wire at Sants in 1905 compared to the situation in 1900-1901. The absolute numbers show a decrease in the main items (zinc, fuel and wages), bringing the product to 69.18 pesetas, 35% less than in 1900-1901. The figures show a change in the composition of the cost price of the aforementioned product: slight increases in zinc, acid-salt and wages and a fall in fuel.

To evaluate Rivièrè's innovative performance and place it in front of the moreover conservative behaviour of the sector, a good indicator could be the speed at which electricity was adopted, a commodity which, due to its abundance and cheapness, would make a powerful contribution to the development of heavy and energy-intensive industries³⁹.

³⁹ Carreras and Tafunell (2021), p. 103; not forgetting Paul David's cautious analogy of electrification with the computerization. Fernández (2005, p. 171) states a scarce technological innovation in the sector as a whole early 20th century.

FIGURE 1. Installed capacity in the metal processing industry in Barcelona



Note: Expenditure has been calculated from a total production of 3 months (239,108 kg) in 1901 and of 184 working days in 1905 (413,674 kg).

Source: Own from AHR. Documents on prices of wire drawing and nails 1897-1900, unnumbered; Sheet of galvanising cost estimates, 13/12/1905.

Firstly, Rivière illustrates the search for the energy formula best suited to production needs and, secondly, the transition from the main central power source to the individual electric motors bringing flexibility to organize and coordinate the equipment and an increase of productivity. The process did not follow a linear sequence that necessarily went from the traditional (steam) to the innovative (electricity). In addition, the two plants of the company show a different pattern. The Sants factory went from a single mode (steam) in 1905 to gas, to the partial electrification in 1909 as a small-scale self-production and to external electric power (Compañía Barcelonesa de Electricidad) first in 1911 and successively in 1913 and 1919. The Sant Martí factory shifted from a dual mode in 1906 - gas engine and steam - to a triple mode in 1912 - gas, a more powerful steam generator (75 hp) and 12 electric engines (61,5 hp) - before returning to dual mode by eliminating gas in 1914. After an extension of the establishment, in 1919-1936 it relied exclusively on electricity and expanded its installed power to 163,22 hp (Table 1)⁴⁰.

⁴⁰ AMCdB, Fo-1,386/1924.

TABLE 1. Installed capacity in the metal processing industry in Barcelona

	Rivière Sants			Rivière Sant Martí			Metalurgia Española		Antonia	Olivella
	Steam	Gas	Electricity	Steam	Gas	Electricity	Steam	Electricity	Steam	Electricity
1904	5.2	60	15	0	0	0	0	0	0	0
1905	11.25	60	15	84,0875	2,5	0	0	0	0	0
	11.25	60	15	84,0875	2,5	0	0	0	0	0
1912	11.25	60	15	152,8375	2,5	61,5	0	0	0	0
1913	11.25	60	77	152,8375	2,5	61,5	0	0	0	0
1918	11.25	60	77	152,8375	0	61,5	0	0	96,25	0
1919	11.25	60	87	152,8375	0	71,5	0	0	0	77,6
1920	11.25	60	87	152,8375	0	71,5	25	0	0	85,6
1921	11.25	60	87	152,8375	0	71,5	25	257,5	0	85,6
1922	11.25	60	87	152,8375	0	71,5	25	257,5	0	85,6
1923	11.25	60	87	152,8375	0	71,5	25	332,5	0	85,6
1924	11.25	60	94	152,8375	0	94,75	0	332,5	0	85,6
1925	11.25	60	94	152,8375	0	94,75	0	332,3	0	85,6
1926	11.25	60	126	152,8375	0	94,75	0	332,3	0	85,6

Source: Based on Calvo (1986), *passim* and AAAB, IP.

In comparison, Antonia Olivella presents some peculiarities: a later adoption of electricity (1918) by replacing steam generators and resorting to external power from Catalana de Gas y Electricidad for engines with power in increasing quantities (from 77,6 hp to 85,6 in 1919 and 107 in 1926). For its part, Metalurgia Española followed a gradual path of electrification, first in the wire drawing section and then in the needle section, as well as a subordinate role of the electric energy (Table 1)⁴¹.

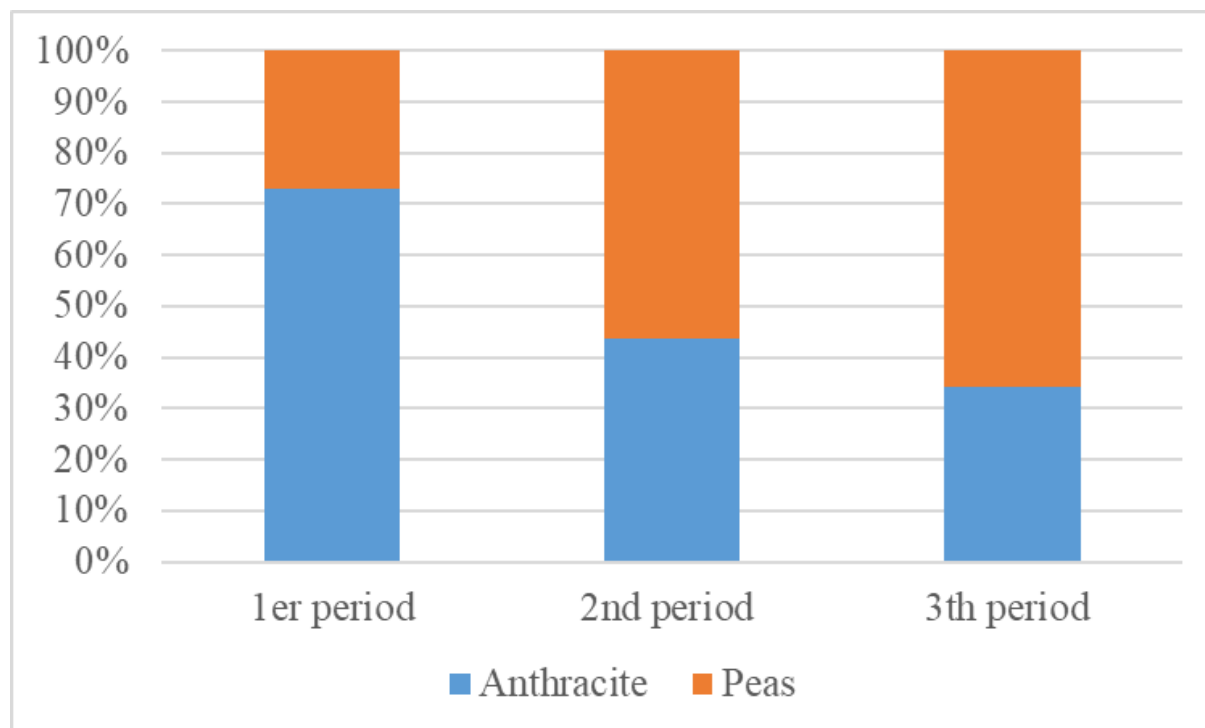
Consider now the driving power costs in the struggle for competitiveness. Cost-cutting trials - substitutions of anthracite for a cheaper fuel (*peas*), and the latter for carbonite- and mixtures of *peas* and anthracite at Sants- achieved important reductions, more pronounced in the anthracite-carbonite modality). In the end, anthracite, came to account for 34.12 % and *peas* for 65.88 % of the total fuel costs (Graph 2).

However, the fuel savings had not led to an overall reduction in the section, because of four hours of compulsory shutdown on the night shift. The company also sought to reduce labour costs through partial mobility in the workplace. It replaced the skilled&unskilled pattern (full-time driver assisted by a part-time auxiliary worker) with a combination of skilled&unskilled (driver and a helper) or by a change in the mode of work (daily driver and overtime plus sporadic reinforcement by labourers from other sections). The combination of these three variables (weekly, overtime and third-party contribution)

⁴¹ Successive installations: in 1920, one 30 hp generator and 26 electric motors (em) with 257.5 hp; in 1922, three em (75 hp); in 1924, 18 em (243 hp) and withdrew 29 em (243.8 hp); in 1925, withdrew generator: Author (1986), p. 819.

causes a significant deviation from the weekly average indicated, with the two extremes ranging from 104.73 to 201.33 % of the basis. On the other hand, wages had no direct relationship with the hours of operation of the engine or the amount of energy consumed, an obvious feature of a fixed remuneration.

FIGURE 1. Composition of engine (50.55 hp 1905) expenses, ptas.



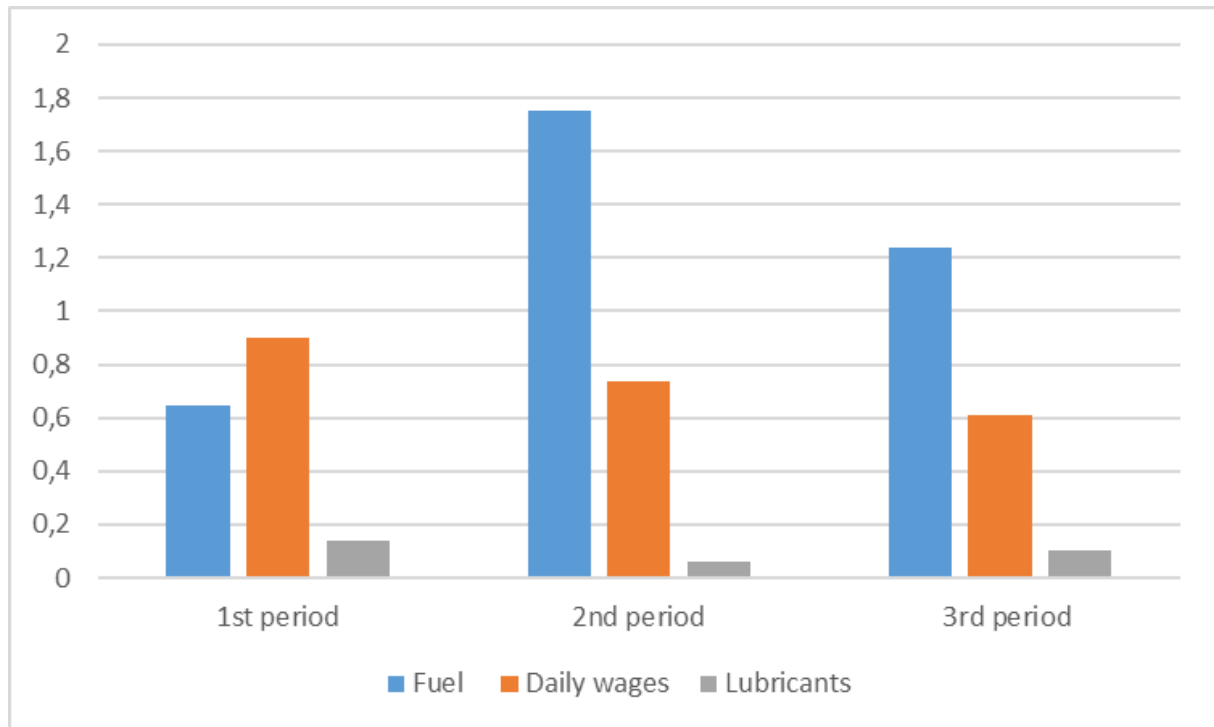
Note: 1st period: 23 February-2 June; 2nd period: 23 February-1 September; 3rd period: 23 February 1905-1 January 1906.

Source: Prepared from AHR, Consumption and general expenses at the Sants factory, 1/1-2/6/1905; General budget of expenses per ton, 25/2-12/9/1905; engine expenses during the 1905 financial year, handwritten sheets.

The changes resulted in a reduction in the absolute figures for fuel costs, counterbalanced by an increase in the percentage figures, a slight increase in consumption per hp/hour and an absolute and percentage reduction in unit costs in daily wages (Figure 3).

In the production system, wages are situated at the crossroads of the interaction of several variables, such as the employers' strategy, the organisation of work, the technical composition of the working class and its demands force. The analysis of the ratios of engine expenditure/operating hour and wages at three different moments in time shows that the energy expenditure per operating hour decreased by 63% and the amount of coal consumed per work-hour increased by 5.5 %. Thus, while fuel expenditure per working time decreased, it increased in relation to the wage, which must translate into a fall in the price of labour.

FIGURE 3. Breakdown of hourly engine (50.55 hp) at Sants, 1905 (ptas.)



Source: Own from AHR, Documents on manufacturing at Sants. Handwritten sheets, 1905.

The share of wages in the cost of production has been described above. A careful reading of the data reveals a complex and varied wage system, depending on the qualification of the worker, the specific task or the job.

The small pickling section - between two and three men - displays weekly rates neither constant nor directly related to the production of the intermediate product - wire rod or “fermachine” - i.e. the rolled wire to be passed through the die to produce the tip (round steel). In weeks with a difference of 10,000 kg of production, the same amount is paid, which would eliminate a form of premium wages. The inequality seems to be the result of the amount of skilled labour employed on a scale where the journeyman's weekly wage (21 pesetas) almost double that of the assistant's (10,80 pesetas).

The wire section offers a more complex scheme in terms of working methods, gender, hierarchy and, of course, skills. Very importantly, here we see an organisational form of work team made up of seven employees (foreman, officer and five workers), a gender composition (three male and two female workers), a group remuneration system (101 pesetas a week) and a hierarchy (foreman - 50 pesetas -, officer – 45% of this figure - and the workers – 57%). This scheme coexisted with piecework for a much higher amount than the previous ones. The figures showed an increase in the number of employees and a change in the composition, with the addition of a male and a female worker. A new feature is a clear gender discrimination, which is added to those by function and

specialisation. Men received about a third of the manager's weekly wage and 66-80% of the journeyman's weekly wage, while women earned 60/66.6% of men's weekly wage⁴².

In the furnace section, two employees combined paid work with a weekly wage ranging from 22 to 16.80 pesetas and overtime. Wage stratification is also evident in carpentry and forging, where apprentices earned between a half and 41.4 % of journeymen. Finally, as a task that required less physical strength and greater dexterity packaging was carried out by women.

The company's predilection for some of the wage systems appears clearly in the wire section, where the manufacturing rate is based on piece work. Each worker is paid a fixed amount per ton produced according to the type and thickness of the wire. The measure stimulates productive capacity and establishes wage inequality. On the other hand, primitive price rates are reduced⁴³.

The various tests resulted in an overall increase in productivity: the output/wage ratio in February-June in the wire section more than tripled.

An important component of the cost structure is the individual and group behaviour of employees in the workplace. In daily practice, the degree of compliance with factory discipline, which is governed by the rules and regulations, plays a significant role⁴⁴. This discipline suffers particularly at times of conflict, as was the case during the three-month strike at the two factories⁴⁵. At Sants, the direct presence of the boss could have generated paternalistic mediations combined with pressure measures and a dynamic that broke the strict discipline imposed by the regulations. This can be seen in three cases. In the first, a worker who complained against the management for non-payment of wages was accused of indiscipline and anarchist sympathies⁴⁶. Another worker, of proven conduct, was accused of breach of trust. The work sheets of two other workers demonstrate the progress of discipline among the working class: neither was the practice of 'St. Monday' systematic, nor did the first day of work after the weekly rest always reduce production. Sometimes the opposite was even true. A wage slip from 1905 for a worker of unknown

⁴² At the Sant Martí factory, the proportion of women ranged from 21% (Rivière Manén, 1959, p. 50) to 40-50% (Fernández, 2004, p. 224). Women excelled as wire workers: Fernández, (2005), pp. 182-183. In a very rare document (AAAB, Gobernación, Serie A, 1.115), not a single woman appeared on the list of 150 workers in the Esparó's pioneer workshop in 1834. In the first third of the 20th century, the number of women increased significantly in the metal industry of Barcelona, became a feminised city because of the destination of a massive female migratory flow from the last quarter of the 19th century: Borderías (2007), p. 166; Villar (2022), pp. 181-217; [out of Barcelona](#), the Sociedad Fábricas de Moreda y Gijón recorded female work (1901).

⁴³ AHR, Documents..., Price rate for the manufacture of wire.

⁴⁴ Through factory discipline, employers wrested from workers control over the pace, hours and manner of work: Clark 1994, pp. 128-163. Work rules codify discipline regimes and contribute to a standardisation and improvement of product quality, quality control and in-plant worker training: Kapás (2012), p.7.

⁴⁵ The strike was joined by Hispano-Suiza and other major centres. Some factories continued to work, protected by the public forces, as well as some small workshops whose bosses accepted the nine-hour working day: *La Correspondencia de España*, 16/10/1910. Work regulations also existed in other factories in the sector, among them the Sociedad Fábricas de Moreda y Gijón (1901).

⁴⁶ He was charged with choosing his own shift, of being close friends with a "militant anarchist" and of being "talkative" and "a friend of partying".

skill, occupation and destination and without any seniority in the factory shows that in 1912 the hourly wage of worker B fell by 28.36% compared to that of worker A and his weekly wage by 31.21%. It is important to underline that in the second case the predominant mode of work was piecework.

Evidence exists of a mixed wage system with a clear predominance of piecework over daily wages (8.08% of total wages for 10% of hours worked on a daily basis; 91.92% of wages for 69.97% of hours worked on a piecework basis). Despite the overall preponderance of piecework, piece-rate hours prevailed for five weeks. The average hourly wage per piece-rate hour was 78.9 % of the piece-rate hourly wage⁴⁷.

Another individual dispute - an accident at work claim - exposes the rigid control exercised by management, which had ready access to the complainant's file. In addition to revealing tensions, it provides information on the type of contract, the daily production - 2,000 kg -, the type of work - piecework -, the annual wage and discipline. The allusion to the form of entry into the factory by recommendation is linked to a tendency to recruit from among the factory's own employees, undoubtedly in search of discipline⁴⁸.

This leads us to explore central aspects of company organisation from a historical perspective. Control, discipline and wage systems lead to the study of the systems of work organisation, an issue about which the sector as a whole displayed serious shortcomings⁴⁹. One of the most significant systems, that preconceived by Fred W. Taylor, sought to increase productivity through analysis to eliminate unnecessary motions and the stopwatch. This system was applied or adapted at least at the Sants factory. In 1905-1906, the production process at this factory was subjected to a series of studies. By means of control mechanisms - production sheets, engine records, individual records for a selected operator, individual production records for several workshops, estimates on orders from outside the factory - the factory's general estimates were drawn up, which made it possible to establish sales prices. The second element on which our presumption is based concerns the existence of factory regulations. The first of its sections laid down the rules relating to the entire workforce: the obligation to work, determination of the exact time of entry to the factory and penalties for lateness, prohibition of physical mobility at the workstation, care of the working tools and the installations in general, behaviour in the event of an accident, allocation of a place for lunch (the courtyard in summer and the premises where the ovens are installed in winter or on bad days), provision for the supply of drinking water and punishment for the spread of discouragement among the staff by dismissal. In addition to general rules, the regulations governing the work of the wire-

⁴⁷ AHR, Documents..., Salary slip of workman Amelón, 152; Sánchez, Series N/1. Complaints, 10, handwritten sheets.

⁴⁸ One example of the worker Sanchez, raised to case status by the IRS (*Bulletin*, 19, 2, 1923, p. 510), makes it tangible. In his file, he was listed as joining the company in 1906 by selective recruitment (recommendation of a religious), his dismissal following an altercation, readmission shortly afterwards and personal background (a dutiful worker, not bad in character, impressionable), prosecution by the military authorities and arrest because of his reluctant participation in the Tragic Week, and, finally, his membership of the Cooperativa Popular de Barcelona.

⁴⁹ Fernández (2005), p. 171.

drawers contained precise indications on the manufacturing process: the task was set by the foreman or by a set of boards; the worker was obliged to complete the entire job within the specified time, which presupposed a wage proportional to the amount of work and the possibility of witnessing the weighing of the pieces carried out by the foreman. Moreover, the completion of the work was not dependent on the professional experience of the worker, but on a manufacturing procedure (number of passes, number of numbers per pass, number of bindings) and, ultimately, to the type of product⁵⁰.

It seems most probable the existence of a hierarchy and a precise distribution of functions and that agencies or individuals were entrusted with specific tasks⁵¹. One more consideration could be added: the setting of the task presupposes prior time-keeping and careful control of the task by the foreman. In short, one of the foundations of Taylorism lies in the establishment of the way production is carried out, which has appropriated the professional knowledge of the worker, reducing him to a mere performer, and transferred control of the work process to the company. Taylorist practices made it possible to go deeper into the wage system. Trials carried out in 1905 with six workers reduced wages by an average of 30.65 %, 17.81 % and 13.14 % for three different types of wire.

4. Corporate innovation, human capital and competitiveness

The analysis of internal organisation leads us to consider briefly the facet of the market and the forms that shape it, in particular cartels, constructions of trust in the expression of Jeffrey Fear. Such insights confirm the close link between the rise of cartels and tariff protection⁵². As it happens in general, one of their essential aspects is the scope of operation: they confine themselves to the market and not to production. Specifically, they stand out in terms of their extreme specialisation: they do not usually cover an entire sector, but focus on one or more products. A significant example can be found in the wire-drawing and nails sector, where F. Rivière e Hijos was a leading player.

We must anticipate that, in the period between the end of the 19th century and the WWI, production costs in the wire drawing sub-sector were rising and competition was intensifying⁵³. A twofold trend then ensued. On the one hand, under protection the manufacturers with the best resources and management capacity followed a dual strategy of agreements first regional and then national and growth by mergers and acquisition of

⁵⁰ AHR, Documents, Wire Drawing and iron nails, 1897-1908.

⁵¹ The documents indicate the contribution of a foreign technician or a member of the Rivière family.

⁵² Freedman (1988), p. 462. Schröter (2013, pp. 989-1,010) defines *cartels* as “*arrangements between independent organisations of the same industry that, by directing competition, aim to influence the conditions of their own business and/or market environments to their advantage*”. Theory cannot tell, a priori, which effect will dominate; cartels success is thus an empirical question: Levenstein and Suslow (2006), pp. 43-95.

⁵³ New players entered the triple twist wire mesh market through diversification (Abad & Ribera –Terrassa-, created in 1918 to manufacture wire drawing): *La Esfera*, 8, 417, 1921.

companies unable to withstand the widespread crisis, albeit with unequal effects⁵⁴. This was the case of the undertakings with the largest size and negotiating capacity in the north and east of the Peninsula, respectively, with the Cantabrian company Quijano and Rivière at the forefront, determined to forge survival agreements on quantities, products and regional market reserves.

Quijano achieved bilateral interregional agreements with the Catalan Rosés some years after the 1891 tariff. Rivière, related to the Torras paper family, and the Navarrese M. J. Perot sealed another similar agreement for 1898-1902 to share the market for wire cloth used in the paper industry⁵⁵. In 1896, Alambres de Cadagua conceived a dual shareholding and market operation to integrate Rivière as a partner and to cede to it territories in the east of the domestic market, namely Catalonia and the Mediterranean coast. In addition, it systematically used exhibitions to launch his products⁵⁶.

Private agreements of this sort and the persistence of difficulties on both the demand and supply sides encouraged corporate collusion in the sector.

At the beginning of the 20th century, Rivière, although well established, maintained a subordinate position on the national market. It was therefore interested in joining forces with manufacturers of a similar category, at least selectively for certain articles, to compete with larger competitors and to gain a foothold.

Known the agreement on prices of triple twisted gratings between Rivière and Marull, one of the minor firms, we address the making of and contents⁵⁷. The first contacts date back to the creation of the internal market and did not leave good memories. Both industrialists traded with foreign metal gratings. Later, around 1896, when Marull became a producer of triple-twisted gratings, Rivière proposed him a partnership to exploit more intensively a recently obtained patent. In view of the counterpart's refusal, Rivière proposed to his contender the subcontracting of multiple-twist wire mesh, which Rivière would sell on the same terms as the manufacturer⁵⁸.

Marull soon took the initiative and asked Rivière for authorisation to use the patent for crimping wires under the threat of manufacturing the product without permission, as he had already started to do on the pretext of his greater experience in the field. The incident postponed until 1905 an understanding between the two companies, whose reasons and basis we know. In substance, it aimed at putting an end to the persisting fall in prices,

⁵⁴ Moreda Gijón, for instance, stopped a section because of repairs and problems in importing some products. The high price of raw materials from England made it difficult and expensive to manufacture steel: IRS (1914), p. 80.

⁵⁵ First contacts with Quijano in 1887 and 1892: Del Hoyo, S. (2021), p. 207. Quijano would provide 1,500 tons of wire per year to Rosés, in exchange for the latter not selling his iron nails on the market in eastern, central and southern Spain. Rivière competed, sometimes to his advantage, in the domestic (Francisco Perot) as well in the international market (Lazare Weiller).

⁵⁶ Rivière-Manén (1959), p. 187.

⁵⁷ AHR, Series E/2, Agreements and contracts with the house of Marull, Handwritten records.

⁵⁸ *Colección legislativa de España*, 1, 1900, p. 409. In 1890, Jenaro Molina had entered the fray with his single and triple twisted galvanised gratings, among other products: *Heraldo de Madrid*, 25/6/1920.

which was the result of rivalry and the organisation of the trading system. It also responded to the need to ensure profits in a context of "major capital" investment in machinery and the risk of premature obsolescence of equipment. Finally, the elimination of unfair competition and the acceptance of the services of personnel - buyers and sales agents - previously linked to the opposing company added strong reasons for the pact. The agreements included the unification of price rates, rebates and discounts on galvanised twist-lock gratings, as well as a minimum price for the other common items. The establishment of a three-year term followed, with the possibility of renewal or termination and the establishment of operating rules and mechanisms in the event of conflict (warning, recourse to mediators, appeal to a third party in disagreement and penalties for minor and serious infringements)⁵⁹.

The preliminary agreement opened the door to broader understandings between the two partners and to possible modifications. Special discounts for resale traders soon followed, and subsequently a discriminatory practice was adopted that favoured demanding customers (raising discounts by 0.5%) and penalised resale traders. In an attempt to mitigate the different categories of customers in the same market, it was intended to classify the market places into three categories and to assign each category a fixed discount in descending order, with the single exception of an additional 4 % premium for a partner -P. Turró⁶⁰.

From the end of 1908, discord interrupted the smooth running. Marull reproached Rivière for breaking the agreement on two counts - rebates and former staff. Thus, the denunciation of the imminent termination of the first extension of the agreement meant complete freedom to sell gratings. For their part, Rivière strove to continue the agreement, not without being wary of possible infringements by their partner in order to prepare the ground. The renewal of the pact in 1910 led to disagreements over the non-respect of the agreed discounts, although Marull openly recognised Rivière's competence and gave him a vote of confidence. In the end, Marull's growing subordination to Rivière and the emergence of a new organisation in the sector put a damper on the agreement⁶¹.

At regional level, manufacturers from the north of Spain – Cantabrians, Asturians and Basques- went ahead with the Sindicato de Puntas y Alambres, It is common knowledge that, in Catalonia, bilateral drawing and aiming agreements preceded broader understandings and allowed the survival and maintenance of independence in times of rapidly changing market conditions. In December 1907, six Catalan manufacturers set up the Unión de Fabricantes de Alambres y Puntas de París (hereinafter referred to as the

⁵⁹ AHR, Series E/2, Agreements with Marull.

⁶⁰ 22% would be allocated to the three extra places - Bilbao, Santander and Gijón; 20% to the seventeen first category places, including Avilés, Cádiz, Oviedo and Madrid, and 17% to the 86 second category places: AHR, Series E/2, Contracts with Marull, Handwritten minutes, 1907.

⁶¹ In 1911, Marull accepted the new price rate for grating proposed by Rivière, who opposed the initiative to lower the price: AHR, Series E/2, Agreements with Marull; Correspondence, 1911.

UnionFAyPP)⁶². This was a real cartel, the axis of a concerted effort at local level "to put forward a common front to the northern Sindicato de Puntas y Alambres"⁶³. The six-year body gave itself powers over prices, arrangements and other conditions. It could set binding price rates and conditions of sale, negotiate agreements with other groups or related entities and set market shares. The agreement gave the members the freedom to determine the volume of production without exceeding the allocated share of sales, with the exclusion of special and standard wires used as intermediate products.

TABLE 2. Market share in the Barcelona metal processing industry, 1905 and 1914

	1905		1914	
	Wires	Nails	Wires	Nails
Hijos de E. Detouche	24,5	26	29	23,5
F. Rivière e Hijos	7,5	13,34	18,75	3,8
R. Rosés	34,8	23	18,75	43,2
Trefilería y Puntería Catalanas	21,0	28	33,5	14,5
Antonia Olivella	8,45	0	0	15
Other	3,75	9,66	0	0
	100	100	100	100

Source: Elaborated from AHR, Series N/4. Complaint by Rivière's solicitor and judgment of the Court of first instance.

Rivière branded the terms of the contract as unfair because he got a share below his possibilities while Rosés reserved an excessive amount of wire. As a sign of understanding, Rivière agreed to cede 25 tonnes of its production to Rosés so that it could cover its quota. Marull, for its part, objected to the market share allocated to it. The disagreements may have been more wide-ranging. When the time came to renew the UnionFAyPP agreement in 1912, the advanced stage of the negotiations to form a national cartel generated a contradictory dynamic of new reasons for friction and encouragement for continuity vis-à-vis potential competitors.

In fact, the creation of the UnionFAyPP paved the way for broader agreements. In October 1908, it concluded a five-year agreement with the Central de Fabricantes de Alambres y Puntas – hereinafter Central- the successor to the Sindicato on agreed price rates, discounts and common conditions. An executive committee with the presence of all the members was to look after common matters concerning sales, settlements and agreements with manufacturers in other regions. The two societies committed themselves to limit their total sales to the quota allocated for each product: 40 % to the UnionFAyPP for wire, and 60 % to the Central. The two bodies had to report their sales and their

⁶² Rivière-Manén (1954), p. 184-188; Fernández (2004), p. 224; Fernández (2005), pp. 165-191; Author (1986), pp. 177-179. Positions: Francisco Rivière e Hijos (vice-president); Ramón Rosés (treasurer); Antonia Olivella (secretary); Trefilería y Puntería Catalanas (member), Emilio Detouche (president) and Ramón Marull Sala (member): Sentencia 20-6-1917, Madrid, 1917. For comparative terms, see Sáez (2006).

⁶³ AHR, Serie N/4, Querella Rosés-Rivière. Ramón Marull was allocated 9.66% in wire, a share which unchanged.

members undertook, subject to a fine of 50,000 pesetas, not to compete in any way outside the company.

Contacts with manufacturers outside Catalonia certainly existed before 1905, when agreements on fixing discounts were in force with Quijano, who moreover favoured adopting Rivière's prices⁶⁴. The forging of durable understandings met with resistance, which some disliked⁶⁵. Shortly afterwards, another manufacturer advocated agreeing a common price for wire cloth and screens. Averly from Zaragoza, a manufacturer of wire cloth and sieves, proposed Rivière's arbitration in the formation of a basis for agreement, mainly on three articles (screens, ordinary cloth and light brass cloth).

Faced with such requests, Rivière possibly consulted with local manufacturers, especially his associate Marull, who was willing to try out a new hawthorn price for six months, applicable to provinces with less penetration of goods from northern Spain. As the negotiations progressed, Rivière tried to measure its real strength, calculated at 51 % in wire cloth, compared with 21 % for Marull, 9,5 % for Averly and 4,25 % for Cebolla⁶⁶.

A nationwide organisation did not take shape until 1913. The recrudescence of competition and specific difficulties encouraged a climate of understanding beyond bilateral agreements. Faced with the announcement of the repeal of the law protecting national industry, the Catalan metalworkers mobilised under the leadership of the FTN. As a result, the First National Congress of Metallurgical Industries (1913) laid the foundations for an industrial organisation of employers in Spain as a whole. It was called the Sindicato Nacional Metalúrgico (SNM) and brought together the two large existing organisations. The Catalan Unión was given the majority share in nails (59 %), a position which was reserved for the Central del Norte de España in wires with a smaller quota (54 %). Once again, the association certified that it was free to fix the volume of production and subject to the quotas agreed for the national market⁶⁷.

⁶⁴ AHR, Correspondence Quijano-Rivière, 12/12/1905.

⁶⁵ Quijano reacted with indignation against the unserious intelligences and without all kinds of guarantees "generally detrimental to those who in good faith respect their commitments".

⁶⁶ Fernández and Sancho (2007), pp. 345-432.

⁶⁷ In the *Revista minera, metalúrgica y de ingeniería* (64, 1913, p. 108) it is listed as S. A. de Alambres y Puntas de París, made up of nine companies: three from Barcelona (Hijos de Emilio Detouche, Antonia Olivella and Ramón Rosés), three from Bilbao (S. A. Alambres del Cadagua, Barbier Hnos. and Federico de Echevarría) and one from each of the following areas: Gijón (Sociedad de las Minas y fábricas de Moreda y Gijón (SMMyG)), Durango (Hijos de Mendizábal), Cantabria (José María Quijano): Quijano (1998); Fernández 2005a, pp. 1-22; Fernández 2005, pp. 439-456. In 1879, an alliance of French capitalists and industrialists with the engineer Isidoro Clausel formed the SMMyG in Paris with an initial capital of half a million francs. The SMMyG joined the Central Siderúrgica, created in Madrid in 1925. The other shareholders were Altos Hornos de Vizcaya, Siderúrgica del Mediterráneo, Duro-Felguera, La Basconia, Santa Ana de Bolueta, Fundiciones de Vera and Unión Cerrajera: *La Nueva España*, 21/4/2009; Elena Toral, Fábrica de Moreda y Gijón (1879), <https://memoriasculturalesdelaindustria.files.wordpress.com/2020/05/minas-y-facc81brica-de-moreda-y-gijocce81n- -elena-toral.pdf>; *Banca, Ferrocarriles, Industria y Seguros*, 25/11/1925, p. 549. The SMMyG produced puddled iron, wires and nails from cast iron acquired in Bilbao; in 1893 it built a workshop:

The action proved to be conflictual once again for several reasons. The first concerned the orientations given in two branches - wires and nails - and involved relations between a company - Rivièrè - and an association - the Syndicate. The second stemmed from Rosés' entry into the manufacture of gratings and was resolved in 1914 when the latter ceded to Rivièrè 6.2 and 2 % of its shareholdings in wire and wire rod respectively. They also agreed on common price rates, rebates and discounts, but only for a very short time. A major external event, the WWI, undoubtedly had an impact on the trajectory of the organisations. The aforementioned pact between Rivièrè and Rosés was first partially annulled in November 1914 and then completely a few months later. Marull withdrew from the UnionFAyPP, complaining about the unfavourable treatment he had received. The remaining members were ready to compete with the dissident house in their speciality products, i.e. gratings.

The new distribution of the market reveals significant changes in the correlation of forces, including an increase in Rivièrè's share in wire and a decline in iron nails, while Rosés strengthened its share in nails and TyPC in wire (Table 2). There is no news of the functioning of the aforementioned organisations, a probable symptom of the disruption of WWI.

After the conflict, with the aforementioned intensification of international competition, the need for cartels and associations regained momentum in the international arena. In 1920, the Union Professionnelle des Fabricants de Toiles Métalliques sans Fin, committed to competitiveness through cost price reduction, invited Rivièrè to join this Anglo-French association aimed at fixing prices for stationery wire cloth⁶⁸. The attitude taken by the manufacturer remains unknown.

In October 1925, seven companies from the northern and Catalan blocks, represented by Quijano and Rivièrè, formed the national cartel Sociedad Anónima de Trefilería y Derivados in San Sebastián. This agreement influenced the long-lasting process of substitution of imports of wire and derivatives and together with the major cartels in Spain meant that the companies involved firmly established their position in the Spanish market. This partly explains leading role they played in the major development of wire drawing and derivatives during the Francoist dictatorship⁶⁹.

In an overall assessment, it could be stated that, despite the strength of the cases studied, there was no strong development of cartels in Catalonia. Reasons such as those adduced by D. S. Landes for the countries with low expansion of cartels, among which he included

Villars (1893), p. 203; it specialised in rolled beams and steel ingot, of which it produced 21,558 t in 1926: *El Sol*, 26/8/1928.

⁶⁸ *Journal Officiel de la République Française*, 1960, p. 7,884; in 1920, it reduced the price of paper machine goods: *La Papeterie*, 43, 1921, p. 238.

⁶⁹ Rivièrè-Manén (1954), pp. 184-88; Author (1986), pp. 177-79; Fernández (2005), pp. 187-88. The Spanish wire-drawing cartel preceded the Belgian cartel by three years.

France⁷⁰, would be valid here: the predominance of light industry over heavy industry and the great weight of family businesses, which would imply a tendency towards entrepreneurial independence. On the other hand, insofar as the ententes constituted an effective antidote to organised workers' resistance, the political apparatus of the political regime of the Restoration was able to make recourse to such entities unnecessary.

5. Conclusions

This research aims to contribute to business history in general by exploring the success factors of a medium-sized firm and the mechanisms of oligopoly formation in non-core capital intensive sub-sector within the leading metallurgy industry in Spain -specialised metallurgy- previously addressed by historiography, first in the 1980s⁷¹ and later since the end of the 20th century⁷². From the methodological point of view, the study has been based on unique primary sources with an interdisciplinary and comparative perspective, together with a comprehensive study plan, covering technological –both in equipment and energy- and organisational innovation.

From a new perspective and with renewed arguments it the research assumes the role of institutional frame and technological change together with the advantages of Barcelona's location and its dual status as an industrial and seaport city. As a whole, the sub-sector benefited from common institutions in the form of protective measures, although not all shared the same bodies (Junta de Comercio) and not all companies managed to survive.

Specialised metallurgy clearly contributed to the diversification of the productive fabric, a process, which in the post-war period of the WWI placed Barcelona's iron and steel industry as a whole in second place among the city's industries, at a distance from textiles and ahead of chemicals. The years 1900-1930 correspond to the period of consolidation of a real industrial structure.

The study has described and analysed a case of success: the formation and trajectory of an import-substitution industry, albeit heavily dependent on the outside world in the context of Barcelona's urban and industrial expansion. However, the research shows that the sub-sector of wire drawing and nails constitutes a niche industry for French entrepreneurs/technicians, a differentiating feature with respect to the experience of other southern European countries.

New personal (manufacturers and even workers) or institutional players have emerged, as well as unknown business situations and relationships. In the non-physical transfer of technology, the modality of forward transfer of knowledge from the headquarters to the

⁷⁰ More recent research reveals a degree of cartelisation in the French economy since the end of the 19th century very high, although lower than in Germany and Austria: Fear (2008); Freedeman (1988), pp. 462-78; Fridenson (1997). Freedeman (1988, p. 462) attributes the growth of cartels to tariff protection.

⁷¹ Author (1985).

⁷² Sancho (1997) and (2000), pp. 61–95; Fernández (2004); (2005), pp. 439-56; (2005a), pp. 1-22; (2005b), pp. 165-91; Del Hoyo (2021).

subsidiary stands out in the sub-sector as a whole. The struggle for competitiveness is centred on lowering costs by various means. Alongside the use of foreign technology, indigenous inventions appear in the innovation process.

The reduction of wage costs appears as a primary concern, using control practices of domestication of the workforce (labour rules and regulations), systems to increase productivity (Taylorism, of great interest because of its relatively early character and its application in a medium-sized company), relevant working methods, such as team, piecework and discriminatory practices based on gender and age. Finally, cost reduction is also embodied in a number of bilateral, regional or national business collusion realisations.

New technologies from diverse origins and forms of organisation were available to all firms but not all took equal advantage of them. The instruments of oligopoly formation were also available to most but not all took advantage of them and some succumbed and were absorbed by the most capable, which at the beginning were not necessarily the largest. The extensive use of invention + innovation and the assumption and exercise of leadership brought the keys to success. In the end, no doubt what makes Rivière an exceptional case is the conjunction of all these elements.

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Innovación tecnológica y empresarial en la metalurgia especializada española: el caso de Rivièrè (1860-1924)

RESUMEN

La metalurgia y el textil constituyen las industrias líderes de la primera revolución industrial en España, rasgo destacado por la bibliografía española desde muy temprano. Uno de sus subsectores, el de la transformación de metales, ha recibido una atención muy especial por parte de los investigadores. Sin embargo, aún persisten ciertas lagunas en algunas ramas, especialmente las relativas a diversos factores del sistema productivo a nivel de fábrica, como el capital -equipos y energía-, la mano de obra y la estructura empresarial. Aquí reside la principal motivación de esta investigación, que aborda las razones del éxito de las empresas medianas de la metalurgia especializada a finales del siglo XIX y principios del XX, utilizando una metodología de estudio de casos, fuentes primarias y el procedimiento comparativo. El texto se compone de tres secciones principales, que comprenden la formación de la empresa Rivièrè, el sistema de producción de esta empresa y su innovación organizativa.

PALABRAS CLAVE: Rivièrè, Innovación tecnológica, Innovación empresarial, Metalurgia especializada

CÓDIGOS JEL: N00, N1, N64, O33, F23

Innovació tecnològica i corporativa a la metal·lúrgia especialitzada espanyola: el cas de Rivièrè (1860-1924)

RESUM

La metal·lúrgia és juntament amb el tèxtil la indústria líder de la primera revolució industrial a Espanya, un tret destacat per la historiografia des de ben aviat. Un dels seus subsectors, el de la transformació de metalls, ha rebut una atenció molt especial per part dels investigadors. No obstant això, encara persisteixen llacunes en algunes branques, especialment les relacionades amb diversos factors del sistema productiu a nivell de fàbrica, com el capital –equips i energia–, el treball i l'estructura empresarial. Aquí rau la principal motivació d'aquesta recerca, que aborda les raons de l'èxit de les empreses mitjanes en la metal·lúrgia especialitzada a finals del segle XIX i principis del XX, utilitzant una metodologia d'estudi de cas, fonts primàries i el procediment comparatiu. El text està format per tres grans apartats, que comprenen la formació de l'empresa Rivièrè, el sistema de producció d'aquesta empresa i la seva innovació organitzativa.

PARAULES CLAU: Rivièrè, Innovació tecnològica, Innovació corporativa, metal·lúrgia especialitzada

CODIS JEL: N00, N1, N64, O33, F23