THE SURVIVAL OF THE FAMILY FIRM IN THE SPANISH IRON AND STEEL INDUSTRY. THE CASE OF *SAN PEDRO DE ARAYA* MILL (1857-1935)

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There is no doubt about the importance of family firms in the first phases of industrialization. The family firm perfectly fitted the technological characteristics and capital requirements of the early stages of industrialisation and, thanks to personal and family relationships[1], gave protection against uncertainty and risk associated with imperfect information flows. The situation changes when we look at the role played by family firms during the second industrial revolution. Throughout much of the 20th century, research into companies concentrated on big businesses that introduced the new technologies of mass production and adopted modern management techniques. In most of the studies into the second industrial revolution, there is no place for the family firm and, when it is given any attention it is to highlight its inability to adopt the technical and organisational innovations introduced by large companies[2]. In the 1980s, some authors began to challenge the Chandlerian paradigm and stress the important role played by small and medium-sized companies and family firms[3] during the second industrial revolution and their valuable contribution to economic growth[4]. The survival of this type of company is often based on the adoption of flexible specialisation techniques or on hybrid models, with one foot in flexible specialisation and the other in mass production[5].

All of the above is especially applicable to the iron and steel industry. The second half of the 19th century saw an important technological transformation in this industry, which resulted in a sharp reduction in costs and a spectacular increase in production. Many companies adopted the new technology (Bessemer and Thomas converters and open-hearth furnaces), which in general led to larger plants and the development of horizontal integration strategies to obtain scale economies, and vertical strategies to reduce the market's dependence on the supply of essential inputs. Accordingly, at the turn of the century large vertically and horizontally integrated iron and steel companies emerged which, in some cases, ended up controlling more than half of the production of their respective countries. Examples of this are *U.S. Steel* in the USA and *Altos Hornos de Vizcaya* in Spain.

Until recent times, studies into the evolution of the sector in the latter decades of the 19th century and the early decades of the 20th century have mainly concentrated on sectorial analysis rather than individual companies[6]. The sectorial analyses are usually based on cost analysis and, when they have included organisational aspects, have been centred on large companies, ignoring the continuing presence of small and medium size companies in the sector. Ingham (1991), in his work on

[1] Payne (1988), Church (1993), pp. 18-19, and Colli, Fernández Pérez and Rose (2003), p. 30.
[2] Chandler (1990) and Lazonick (1991). In the 1970s, authors such as Kindleberger or Landes blamed the family company for the decline of British industry during the second industrial revolution. Church (1993), p. 21.
[3] Church (1993), Jones and Rose (1993) and Rose (1994).
[4] Scranton (1997).
[5] Sabel and Zeitling (1997) and Zeitling (2003).

independent iron mills in Pittsburg, shows that faced with the growing influence of the large companies, small and medium companies, many of them family firms, not only survived over several decades but were also capable of risk assumption and innovation. Generally, these businesses managed to survive by developing strategies directed towards finding niche markets in which the large companies could not successfully exploit their scale economies. In most cases, this strategy involved the adoption of hybrid or mixed models of productive organisation[7].

These mixed methods of organising production were adopted by the majority of Spanish iron and steel companies, which allowed some small family firms to survive[8]. This study analyses the case of a small iron and steel company from the north of Spain, the *San Pedro de Araya* mill, which for a century belonged to a well known dynasty of Spanish businessmen, the Ajuria-Urigoitia family. From the mid 19th until the mid 20th century, the ownership and control of the firm were closely linked and members of the family were involved in both the overall strategy and the day to day running of the company. In the following pages, I will go over the history of the ironworks from its origins in 1847 until the Spanish Civil War (1936-1939). The study is especially focussed on the company's response to the significant changes experienced by the Spanish iron and steel industry which began in the final decades of the 19th century, with special emphasis on strategies based on finding profitable niche markets and on the adoption of the most suitable technology to achieve this objective. I will also consider the issue of leadership succession. The death of the founder of the company in the mid 1880s, just as the sector was going through great technological and organisational transformations, allows us to show the difficulties inherent in family firm leadership succession, and also the possibilities of success when it is well planned[9].

1. León Urigoitia. The entrepreneur

The appearance of the first modern ironworks in Spain was due, to a large extent, to a change in the institutional framework. The first step was the 1826 tariff that restricted the national market to national producers by prohibiting the importation of a good number of iron products. Originally designed to protect traditional industry (bloomeries), it ultimately favoured the appearance of modern ironworks in the south of Spain (Andalusia) which were later followed by new mills in the north, mainly in Asturias and Biscay.

However, between 1841 and 1891, commercial policy in Spain moved more and more towards free trade, especially in iron related industries, which notably limited the development of the national iron and steel industry. Until 1891, imports of machinery and iron ships were charged with very low

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[6] Burn (1961), McCloskey (1973) and Tolliday (1991), for Great Britain; Wengenroth (1994), for a comparison between Germany and Great Britain; Temin (1964) and Misa (1995), for the USA, and Fernández de Pinedo (1983), Bilbao and Fernández de Pinedo (1988) and Nadal (1975), for Spain.

[7] See Scranton (1997), chap. 1 and Zeitling (2003), pp. 65-67 and 72-73, for the mixed methods between flexible specialisation and mass production.

[8] In the case of Spain, the shortage of coal deposits, their low quality and the technical difficulties surrounding their exploitation, along with the particular characteristics of the Spanish market, gave rise to a mixture of techniques of various origins –mainly French, Belgian and British- and the predomination of hybrid models that combined both mass production and flexible specialisation. Fernández de Pinedo and Uriarte Ayo (2005), p. 170.

[9] See Rose (1993) for the importance of planned succession in the continuation and prosperity of family firms.

import tariffs, material destined for the construction of the railways could be brought into Spain without any tariffs, and there were frequent exemptions for material to be used in public works. In this way, although the tariffs of the second half of the 19th century kept a part of the domestic market for national industry by protecting pig iron and the most common bar iron (merchant bar iron), the Spanish iron industry was deprived of the most dynamic markets and therefore condemned to slow growth until the end of the 19th century[10].

The *San Pedro de Araya* mill made its appearance in the context described above. In 1847, various investors from Madrid and Vitoria (a small city in the Basque Country) founded a company with the aim of starting a modern ironworks in Araya, a small inland Basque village. The factors that led to them investing in this small village, in which there were no modern mills, were as follows: firstly, the opportunities provided by the institutional framework thanks to the 1826 and 1841 tariffs, along with the prospects that would be opened up by the construction of the railways in Spain; secondly, the existence of a labour force qualified in iron related activities, as there had been a bloomery in operation since 1772; and finally, the natural resources of the area, which included large forests for the provision of charcoal and hydraulic resources sufficient to move part of the machinery of a modern mill, which compensated for the lack of coal.

Despite the good prospects offered by the business, the ironworks led a languid life during its first decade, with continual changes to its share capital and management. It did not really take off until 1858, when it was bought by a group of merchants and industrialists, who created a new company called *Sesé, Urigoitia y Cia* to run the business. The management of the firm fell to León Urigoitia, who had already been engaged in iron production as he had managed a bloomery in Araya with his father; for years he had also been developing production and commercial activities around the exploitation of forest resources in the area. He was, therefore, a typical case of the worker-capitalist who provided the technical expertise in iron making and in complementary activities. León Urigoitia had the help of the English engineer Eduardo Hickman, who was in charge of technical management, to face the challenge of modernising the ironworks and turning it into a profitable business.

When the new partners took over the Araya mill, its iron production operations, along with those of most Spanish ironworks at the time, were integrated, so that blast furnaces, refining furnaces and puddling furnaces were at the same building. The technological renovation, led by Urigoitia and Hickman involved the substitution of the refining furnaces, which were fed by charcoal, for modern puddling furnaces, which fuelled with coal. This resulted in a notable reduction in the consumption of charcoal, although it was still used to fuel the blast furnaces[11]. They also substituted the iron ore, obtained from nearby mines, for Biscayan ore, which was more suited to charcoal blast furnaces.

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[10] See Nadal (1975), Bilbao (1983) and Fernández de Pinedo (1983 and 2001), for the role of tariffs in the configuration of the Spanish steel market.

[11] The technological pattern adopted by the Araya mill, i.e. the smelting of the ore in charcoal blast furnaces and refining in coal-fed puddling furnaces, was the most common in Spanish iron industry at the time. Fernández de Pinedo and Uriante Ayo (2005), p. 170. In 1866, Spain had 27 charcoal blast furnaces and 8 coke-fired; the first provided 57.6% of the pig iron produced and the second, the remaining 42.4%. In the same year, the production of charcoal pig iron was only 0.12% of the total in Belgium and 15% in France. Nadal (1970), p. 219 and Fremdling (2005), pp. 49-52.

The transformations quickly generated high profits, from which León Urigoitia benefited in particular due to the triple role he had in the company. Firstly, he owned 20% of the shares; secondly, he took a part of the profits based on his management work; and thirdly, he received 6% interest from the large loans he had made to the company since its inception. Despite the large profits, the more and more free-trade character of Spanish commercial policy and the 1870s economic depression led some of the partners to consider leaving the company and selling their shares. Between 1862 and 1870, León Urigoitia, who from the end of 1859 and the departure of Hickman, directed the company alone, gradually acquired the shares of his partners until he was in full possession of the firm. From this moment until his death in 1886, León Urigoitia had absolute control of the firm in terms of both ownership and management.

During this time, the main problem he faced was the growing competition from within the sector, especially from Asturian and Biscayan companies, which had much lower production costs. To appreciate the increasing difficulties the firm met at this time, we need to look at the broad picture of the Spanish iron industry. In the 1870s, the Araya mill had some 120 workers. Their annual production capacity was of around 2,760 metric tons of merchant bar iron, which was very similar to that of some other Spanish ironworks, although far behind the levels reached by the two largest companies of the sector (see Table 1).

TABLE 1. Production capacity of bar iron of the main Spanish ironworks in 1871 (in metric tons)

Duro y Cia (Asturias)	11,040
El Carmen (Biscay, Basque Country)	6,900
El Remedio (Barcelona, Catalonia)	4,140
Mieres (Asturias)	3,450
Bolueta (Biscay, Basque Country)	3,450
Beasain (Guipúzcoa, Basque Country)	3,220
Araya (Álava, Basque Country)	2,760
Jáuregui (Biscay, Basque Country)	1,840
Heredia (Málaga, Andalusia)	1,380

Source: Sáez García (1999), p. 178.

The Asturian iron makers enjoyed a great advantage over their competitors thanks to the lower cost of coal from the mines of the region. In contrast, the other Spanish producers did not have coal mines close by, which meant that they had to import English or Asturian coal. For their part, the Biscayan producers benefited from the lower cost of iron ore, because they had rich deposits of high quality ore very close to their installations[12]. This resulted in great differences in production costs among the various regions of Spain. In the mid 1870s, producing a tonne of pig iron in a coke blast furnace in Asturias cost 90.70 pesetas and 106.25 in Biscay, whereas a tonne obtained from the charcoal blast furnaces of Araya cost 143.88 pesetas. The Asturian advantage was increased when it came to refining the iron in puddling furnaces, because this phase required coal. Hence, in Araya, the

[12] In general, the Asturian ironworks had vertically integrated by acquiring coal mines, while the Biscayans owned large iron ore exploitations. See Díaz Morlán (2002a), chap. 5, for the vertical integration processes of the main Biscayan ironworks. See Ojeda (2000), chap. III, for the Asturian *Duro-Felguera*.

production costs of a tonne of wrought iron rose to 269.75 pesetas, of which coal accounted for 45. Conversely, in Asturias, the coal costs to produce a tonne of wrought iron were only 14.5 pesetas, with a final production cost of 163.2 pesetas, as opposed to the 194.68 of Biscay[13].

With these enormous cost differences, the survival of the Araya ironworks might seem surprising. However, one of the key aspects of its continuity was its closeness to the markets. Thus, while other companies were faced with the difficulties of moving their products due to transport network deficiencies, Araya had the advantage of being very close to the railway linking Madrid with the western end of the French border, which allowed it to enjoy benefits over Asturian and Biscayan companies when transporting its products to Madrid and the inland regions of the northern half of Spain. The advantages were not limited to much lower transport costs as the proximity of the markets also gave it more agility in terms of supplying orders. Additionally, it should not be forgotten that for the traditional metallurgy activities –to which most Spanish iron production was directed at the time-, wrought iron from charcoal pig iron was preferred over the wrought iron produced from coke pig iron because of its greater malleability[14].

However, as the railway network improved and there was greater integration of the national market, the difficulties of ironworks still using charcoal in their blast furnaces increased. Because of this, they had to find alternative ways of surviving the competition of coke blast furnaces. In the case of Araya, the difficulty of adopting coke for its blast furnaces was its relatively long distance from the Cantabrian ports, which was translated into high transport costs for coal and coke from Asturias or Great Britain. The Araya ironworks was situated at the foot of the largest forests in the Basque-Navarre region, which gave it a supply of charcoal at a good price for its blast furnaces. Thus, León Urigoitia chose to keep the charcoal blast furnaces to smelt the ore, while at the same time introducing improvements designed towards fuel savings at the refining stage. The Araya mill, as with the main Spanish ironworks with charcoal blast furnaces, adopted a procedure developed by the French engineer Jean Barbary Langlade, to save fuel in the refining and rolling[15]. The system, which was used from 1873 in the Bolueta mill (Biscay), used the combustible elements present in the gases expelled by the blast furnace to produce the calorific energy required to heat the puddling furnaces, which with this method, needed no other fuel.

In 1881, León Urigoitia introduced the Langlade system to heat the puddling furnaces at the Araya mill. The good results obtained encouraged him to use the same system for the reheating furnace two years later. The satisfaction of the owner of the Araya ironworks with this technique must have been great, because, in 1884, he contacted Langlade again to express his desire to set up another puddling furnace using the system. Thus, by the middle of 1889, along with the three single coal-fired puddling furnaces, the ironworks had another two, one single and one double, which were

[13] The costs data come from the *Información sobre el derecho diferencial de bandera* (1867). The costs of the Araya mill are similar to those of the majority of the inland ironworks in Spain that fed their furnaces with charcoal and refined the pig iron in puddling furnaces.

[14] See Fernández de Pinedo (2001) and Sáez García (2004) for the importance of the traditional demand for Spanish ironmaking.

[15] Alonso Olea, Erro Gasca and Arana Pérez (1998), p. 90 and Sáez García (1999), pp. 71-73. See Belhoste and Woronoff (2005), pp. 91-92, for the first experiences of the recovery of gases from blast furnaces to heat puddling and reheating furnaces.

fired by the gases from the blast furnace, to which we should add another double which was under construction[16].

Thanks to the use of the Langlade process, from the mid 1880s, Araya achieved significant fuel saving in the refining and in the rolling mill. Between 1887 and 1891, the production of a unit of puddled iron required 0.37 units of coal, as opposed to 1.45 in Asturias and 1.10 in Biscay. The differences in fuel consumption were also important when transforming the puddled iron into bar iron. While the Asturians were using 1.2 units of coal per unit of shape iron, they were using 0.8 units in Biscay and only 0.01 units in Araya. In this way, the production costs of a tonne of puddled iron in Araya (178.5 pesetas) were very similar to those of the Biscayan ironworks (178.2) and only 10% more than in Asturias (159.9). This production cost reduction was enough to ensure that the companies that had adopted the Langlade system could continue making wrought iron from charcoal pig iron, and were able to compete with the Asturian and Biscayan wrought iron produced from coke pig iron. This situation lasted until the beginning of the 20th century, when wrought iron began to feel the full effect of the competition from steel.

2. Leadership succession: survival in the age of steel

During the two final decades of the 19th century, the Spanish iron and steel industry went through important changes. The appearance of new production steelworks in Biscay, which were much larger than earlier Spanish ironworks, brought about a spectacular increase in production. At the same time, the main companies in the sector started to incorporate the new manufacturing techniques which were slowly taking over from puddling furnaces. The technological renovation was accompanied by a process of vertical and horizontal integration by the principal firms. The process culminated in 1901 with the founding of the *Sociedad Metalúrgica Duro-Felguera* in Asturias and the merger of the main Biscayan iron and steel companies in 1902 to create *Altos Hornos de Vizcaya*, a firm that was to lead the Spanish iron and steel sector for the whole of the first half of the 20th century. The organisational and technological changes gave this new company significant scale economies which led to its control over half of the Spanish market. This increased market share, especially in terms of merchant bar iron and steel, was achieved at the expense of the small and medium-sized companies in the sector, which had to use specialisation strategies to combat the scale economies of the large firms (see Tables 2 and 3).

TABLE 2. Allocation of quotas of bar iron in the iron and steel cartel, 1902 (in %)

Members	***Percentage***
Altos Hornos de Vizcaya	31.00
Sociedad Metalúrgica Duro-Felguera	16.35
Mieres	16.35
Moreda and Gijón	7.60
Material para Ferrocarriles y Construcción	4.50
Elgoibar (Hijos de R. García)	5.52
Araya (Vda. de Urigoitia e hija)	5.47

[16] Sáez García (1999), pp. 72-73.

Vera de Bidasoa	5.13
Santa Ana de Bolueta	3.50
Astepe (Hijos de Jáuregui)	3.33
Federico Echevarría	1.25

Source: Sáez García (2005), p. 147.

TABLE 3. Allocation of quotas in the Central Siderúrgica. 1908-1916 (in %)

Members	***Merchant bar***	***Beams and U sections***	***Sheets***
Altos Hornos de Vizcaya	49.00	45.00	56.40
Sociedad Metalúrgica Duro-Felguera	13.00	31.85	27.60
Mieres	13.00	2.50	6.00
San Francisco	6.00	10.00	10.00
Moreda and Gijón	6.00		
Material para Ferrocarriles y Construcción	4.00	10.65	
Hijos de Romualdo García	4.00		
Santa Ana de Bolueta	2.25		
Fábrica del Bidasoa	1.50		
Unión Cerrajera	1.25		
TOTAL	**100.00**	**100.00**	**100.00**

Source: Central Siderúrgica (1908-1916).
Note: The *San Pedro de Araya* ironworks, which had participated in most of the previous cartels, did not join this one because it disagreed with its assigned quota of 1.75% for merchant iron.

This period of important changes in the sector coincided with a complicated leadership succession at the Araya ironworks. As we all know, succession is the most important issue faced by family firms. In fact, specialists in family firms have put succession at the centre of their analyses and it is also one of the most important subjects analysed by historians in their case studies[17]. The case in hand is a good example of how succession takes place in a family firm, with the added complications of great changes in the sector[18]. In the Araya ironworks, the preparations for succession met with difficulties that led to the management of the company passing directly from the founder to members of the third generation. León Urigoitia had two children, Serafín and Emilia. As usual in those times, the daughter was kept out of the family business while the son was an active participant in the management of the company with the objective of taking over when his father died[19]. However, the death of Serafín in 1879 changed the succession plans. On his death, Serafín left behind a widow and three young daughters. His sister Emilia, had married a Bilbao merchant, Antonio Ajuria, with whom she had by then had several children including two sons. Things as they were, León Urigoitia decided

[17] See Colli (2003), p. 65 and ss. and Colli, Fernández Pérez and Rose (2003), pp. 33-35, for the recent developments in the literature on leadership succession in family firms.

[18] Rose (1993), p. 128, points out that "there is considerable evidence to suggest that the majority of family firms do not enjoy longevity and that at least part of the problem lies in the failure of business leaders to plan their own succession".

[19] We should bear in mind that at the turn of the century in Spain, women had no legal means of carrying out commercial activities.

that when he died, management control of the business would pass to his son-in-law and his male grandchildren[20].

The planning of the succession began with the change to his will, in which, given that the inheritance laws prescribed an equal division among heirs, he named his daughter Emilia and his granddaughters (Serafín's daughters) as universal inheritors. In his will, León Urigoitia ordered that his granddaughters received their share in cash and in government bonds, whereas his daughter would be given half of the ironworks with everything necessary for its operation[21]. The other half of the factory would go to his widow Tomasa Urniza, as the half of the shared possessions she was entitled to. In this way, León Urigoitia was assured that the ownership of the company would remain in the hands of his direct descendents and avoided the dispersion of the capital by keeping the business within one branch of the family[22].

1886 saw the death of León Urigoitia and the transfer of the property to his widow and daughter, and the company changed its name to *Viuda de Urigoitia e hija*. With regard to the manner in which the inheritance was shared, it should be stressed that the value fixed for the ironworks, both in the will and the deed of the new firm, was much lower than the value assigned to it in accounts prior to 1887. Moreover, once the new company was registered, the value of its shares, according to the accounts, rose again although there were no new investments. It is clear that the objective sought by reducing the share value of the company was to benefit the inheritors of the family business.

The planning of succession not only implies the sharing of goods among the inheritors, but also the training of those who are going to lead the business. This was understood by León Urigoitia, who, after the death of his son Serafín, looked after the training of his grandsons so that they could take over the family business. With the help of his grandfather, the eldest, Alfredo Ajuria, studied industrial engineering at the Barcelona school and, at the beginning of the 1880's, he was sent to France, Belgium and England to see the advancements in the iron and steel industry for himself. The other two grandsons born before his death, Carlos and Serafín, were left enough money to pay for their studies. Carlos Ajuria graduated at the Royal School of Mines in England in 1894, and before joining the family business worked in a mining company in León. Serafín Ajuria studied law in Spain[23].

After the death of León Urigoitia, the new owners of the company appointed Antonio Ajuria Sarralde and Alfredo Ajuria Urigoitia as managers. This not only meant that the two owners were giving up the running of the firm, but also that they were giving up the right to decide who would run it

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[20] See Valdaliso and López (2000), pp. 389-393, for the role of sons-in-law in revitalising the entrepreneurial spirit of family firms. Some good examples on this subject can be found in Díaz Morlán (2002b), pp. 287-292 and Fernández Pérez (2004), p. 91.

[21] As Colli, Fernández Pérez and Rose (2003), p. 41 show, this form of inheritance, which gave male descendants the business and the female descendants property or other assets which allowed them permanent incomes, persisted throughout most of Spain until well into the 20th century.

[22] This strategy was also quite common in Italian textile and metallurgy companies, especially in the first phases of the industrial revolution. Colli, Fernández Pérez and Rose (2003), p. 38.

[23] This case is quite similar to the observations of Colli (2003), p. 68, in Italy during the second half of the 19th century: "In the Italian case, the economic backwardness of the country and the will to industrialise during the second half of the nineteenth century encouraged the first entrepreneurs to manage the training of their heirs. This happened not only inside the firm but also by means of sending heirs abroad –particularly to France, Germany, and Britain, where they could learn the most recent technical innovations". In Spain, we have the cases analysed by Fernández Pérez and Puig (2004).

in the future. This is recorded in the deed of the company *Viuda de Urigoitia e hija*, in which Tomasa Urniza and Emilia Urigoitia agree to leave the administration and management of the business to Antonio and Alfredo Ajuria or to anyone that the latter two appointed. The owners would only recover their right to appoint new managers in the case of the resignation of the two Ajurias or the physical incapability of them to continue at the head of the firm.

In 1897, Carlos Ajuria also joined the management of the company. He very quickly took the lead of the business and kept it until his death in 1935, although he shared the management tasks until 1904 with his brother Alfredo and from 1918 with his brother Francisco[24]. During this whole time, the Ajuria brothers personally looked after both the management of the business and its technical development without having to resort to appointing engineers or administrators from outside the family. With regard to the ownership of the firm, after the deaths of Tomasa Urniza and Emilia Urigoitia, the business passed into the hands of ten of the eleven children that Emilia had had with Antonio Ajuria. The ten brothers and sisters formed a company called *Ajuria and Urigoitia* in 1918, with a similar share in the capital for each of them. Despite the fragmentation of the property among the heirs, the management of the firm remained as it has always been: a simple organisational structure in which the most important decisions were taken by Carlos Ajuria, aided by the opinions of the male members of the family.

In the years when they were in charge of the business, the Ajuria brothers had to face growing competition brought on by the economic depression at the end of the century and, especially by the replacement of iron by steel in a great number of applications. With regard to the latter issue, until the beginnings of the 1890s, wrought iron had been able to resist the competition from steel made by the Bessemer and Thomas converters and by the acid open-hearth furnaces, because of its greater malleability, its resistance to corrosion and because puddling process made no demands regarding the composition of pig iron[25]. However, in the final decade of the 19th century, puddled iron met a strong rival in the form of the basic open-hearth steel. The basic open-hearth process was the only one of the new making steel technologies which was capable of finally replacing the old puddling process, because of both the quality of the steel it could make, which could replace wrought iron in the majority of its applications, and because of the types of pig iron it could use[26].

Table 4. Comparative iron and steel production costs, c. 1899 (PTA per ton)

Basic open-hearth ingot steel. Asturias		***Puddled iron. Araya***	
Inputs	***PTA***	***Inputs***	***PTA***
Coke pig iron	70.6	Charcoal pig iron	112.4
Coal	6.3	Coal	0.0
Labour costs	7.0	Labour costs	15.4
Others	6.0		

[24] Antonio Ajuria, operating as a merchant in the city of Bilbao, shared the management with his son Alfredo until 1893. Alfredo left the company in 1906, leaving his brother Carlos in charge.

[25] The composition of the Thomas steel was very similar to that of wrought iron, which meant that it could be used for the same applications. The main limitation to the spread of this technique was the type of raw materials it required, as it needed pig iron with a high phosphorous content (2%). In contrast, puddling had no particular requirements with regard to the composition of the pig iron. Wengenroth (1994), p. 24

[26] Wengenroth (1994), p. 30.

Total	***89.9***	***Total***	***127.8***

Source: Ojeda (1985), p. 255, for Asturias; and, Sáez García (1999), p. 76, for Araya

As can be seen in Table 4, the difference in production costs between puddled iron and basic open-hearth steel was very significant at the end of the 19th century. However, due to the existence of cartels in the sector, the competition from steel was not fully felt until 1904. Helped by the protectionism began by the 1891 tariff, the majority of the sector came together to make price agreements, which gave them great stability and led to high profits. These circumstances would not last long, as the high prices set by the cartel stimulated the appearance of new companies, which finally brought about an over-production crisis in the early years of the new century. The immediate consequence was the breaking of the agreement at the beginning of 1905 by the leading firm of the sector, *Altos Hornos de Vizcaya*. The new situation provoked an increase in competition with the consequent price reduction. Ironworks that continued to base most of their production on traditional technology (charcoal blast furnaces and puddling) saw their products displaced in the market by steel, notably reducing their profits.

The key points to the survival of the San Pedro de Araya ironworks can be found in a strategy based around, on the one hand, finding profitable market niches in the market for its traditional products and, on the other hand, diversification through the introduction of new products with which the large companies could not take advantage of their scale economies. Product diversification was vital for the continuation of the firm as it was a way of spreading risks and compensating for demand fluctuations in merchant bar iron[27].

2.1. *Technological innovation: the electric furnace*

Despite the efforts made during the 1880s to reduce the costs of puddling, in the final years of the century it was clear, as we have just seen, that puddled iron could not compete with basic open-hearth steel. Therefore, it was necessary to find alternatives to the traditional techniques. In this respect, it is important to note that the decisions adopted by the Araya mill owners demonstrate that family firms are not synonymous with risk aversion or lack of innovation. From the beginnings of the 20th century, the efforts of the Ajuria brothers were directed towards finding new techniques to replace the antiquated puddling process. However, given the availability of factors of production – the only natural resources in the area were charcoal and hydraulic power, and even these were not exactly in abundance -, neither the open-hearth furnaces nor the Bessemer converter seemed to be the solution. Also, production costs would have been much higher than in Asturias or Biscay, as transport costs would have added a lot to the cost of raw materials (coal and iron ore).

However, there was another option: using the hydraulic resources of the area to produce steel. From the beginning of the century, they carried out the work necessary to re-direct several of their waterfalls into one main channel. The new waterfall, which was initially only used to move the turbines

[27] The innovations introduced by the Ajuria brothers in the 1890s also included labour changes: piecework in puddling and rolling in order to increase productivity.

that operated the machinery, was also used to light the workshops and, most importantly, at the end of 1906, to run the first electric furnace for steel in Spain.

The importance of this innovation can be better understood if we bear in mind that the first electric furnace for steelmaking had been patented only ten years earlier by G. Gerard. Two years later, the Italian C. Stassano patented an electric furnace to make iron directly from ore. However, the procedures in regular use around 1906 were patented at the beginning of the century: Kjellin (1900), Hèroult (1901) and Keller (1901)[28]. Given their short history, electric steelmaking procedures were not in widespread use and were only common in Sweden, Norway, France and Germany, whereas they were not introduced in the USA until 1906[29]. It should be stressed that the adoption of the electric furnace was a promising investment, given that in those years, they were betting on the possibility that electric furnaces would replace converters in steelmaking; however, until after World War II they were mainly used to make high quality steel and iron alloys.

At the moment of deciding on the type of furnace to install, the Ajuria brothers opted for the furnace patented by the Swedish engineer F. A. Kjellin. The furnace installed in Araya was similar in capacity and arrangement to the furnace that had operated since 1902 in the Swedish city of Gysinge. The objective was to make quality steel from charcoal pig iron. The new furnace was to meet with a serious problem from the beginning: the lack of water during the dry months. Hence, once installed, the summer and autumn drought stopped it from operating until the end of the year. Moreover, the results obtained from it were unsatisfactory. The unsuitability of the furnace for the raw materials available in the area, the costly patent rights and its high energy consumption led to its only intermittent use until 1911, when the company decided not to use it again[30].

The poor results obtained from the Kjellin furnace did not discourage the Ajuria brothers, who decided to install a new electric furnace. On this occasion it was a Louvier-Louis electrode furnace, which they used to make tests in producing steel and iron alloys, to be precise, ferrosilicon with a silicon percentage of 45 or 50%. This alloy was used as a deoxidiser in steel refining and as a fixed addition in the making of steel for springs and soft steel sheet. If the raw materials required by the Kjellin furnace (magnesia for lining and very pure scrap) brought high average costs as they had to be imported, the complete opposite was the case with the new process, as it could use all types of scrap and, moreover, used less electricity.

The new furnace started operation in 1910; however, its production was definitively stepped up thanks to the favourable conditions created by World War I. The war brought about a drastic decrease to importations of ferrosilicon and ferromanganese. These iron alloys were necessary for the final steel refining phase and were not produced in Spain. The owners of the Araya mill took advantage of the gap created by the fall in imports and decided to use the furnace for the exclusive production of iron alloys. Although they made some ferromanganese, they preferred to concentrate on

[28] *Revista Minera Metalúrgica y de Ingeniería* (1904), p. 462.

[29] *Revista Minera Metalúrgica y de Ingeniería* (1906), p. 621 and Misa (1995), p. 248.

[30] As shown by Fernández de Pinedo and Uriarte Ayo (2005), p. 172, one of the main problems of the iron and steel sector when adopting foreign technology was the lack of homogeneity in the raw materials used. In our case, neither the local pig iron,

ferrosilicon, of which they were the only producers in Spain and, therefore, supplied the other steelworks. With such favourable conditions they were able to sell everything they made with the electric furnace which, due to the lack of hydraulic power during the summer, only worked for eight months of the year.

Once the war was over, the production of iron alloys was notably reduced due to competition from imports. The reduced demand led the company to consider the possibility of using the furnace to make tool steel instead of ferrosilicon. However, sales recovered and, from 1928, there was a growing demand for ferrosilicon, which allowed them to sell their whole production. In fact, despite the 1930s depression, sales grew from 95.6 tonnes in 1929 to 132 in 1931 and 197 in 1933. However, the strong seasonal aspect of its production, as a consequence of water scarcity in the summer, prevented them from meeting all the orders they received for this product. An attempt to solve this problem was made in 1935, when they looked into the possibility of buying electricity from the *Sociedad Hidroeléctrica Ibérica* during the dry months, but once they discovered the high prices of this company, they decided to reject the idea.

In summary, despite being a medium sized family firm, innovation was not absent in their response to the crisis suffered by traditional processes around the turn of the century. However, innovation should be understood in this case not as the introduction of radically new products or processes, but more as the adaptation of innovations developed by others to the peculiarities of the company; in particular to the avoidable natural resources and the characteristics of the Spanish market.

2.2. Niche markets for traditional products

World War I gave some breathing space in the crisis faced by the traditional iron industry since 1904. The least efficient production ironworks benefited from the considerable price increases of iron and steel products. Naturally, labour and raw material costs, especially fuel, also felt the impact of the war, which meant that average costs soared between 1915 and 1919. However, this was more than compensated for by price increases of shaped iron, which multiplied 3.7 times between 1913 and 1918.

However, once the war was over, the traditional processes were in a full crisis situation. The lower competitiveness of wrought iron in comparison with soft steels was once again fully felt. In 1921, there were still 35 puddling furnaces operating in Spain and making 16,287 tonnes; far behind the 359,897 tonnes of steel produced in the same year[31]. In the years that followed, these furnaces were being rapidly extinguished until in 1929, Araya was the only ironworks in Spain still making puddle iron. With regard to charcoal blast furnaces, there were six in 1922, all of them in the Basque Country and Navarre, and their production was 12,433 tonnes, as opposed to the 197,359 made with coke[32]. As with the case of puddled iron, in 1933 Araya became the only maker of charcoal pig iron.

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nor the refractory materials were suitable for the Kjellin procedure. This was not the exclusive problem of electric furnaces, but also affected other steelmaking technologies. Abe (1996).

[31] *Estadística Minera and Metalúrgica de España* (1921).

[32] *Estadística Minera and Metalúrgica de España* (1922).

The Araya mill had not generally commercialised charcoal pig iron, as all that it made was used in the puddling furnaces. However, from the mid 1920s the demand for this product from smelting and forging mills rose, as charcoal gave the iron certain special characteristics not present in coke pig iron. Moreover, the company benefited from a reduction in supply, as at the end of the 1920s, there were only two other ironworks, one in Navarre and another in Guipúzcoa, still producing this product. By 1933, these two companies had blown out their blast furnaces, leaving Araya as the only ironworks making charcoal pig iron in Spain. Hence, aided by steady demand, mainly from Basque Country smelting and forging mills, the ironworks saw their pig iron sales rise from 300 tonnes in 1929 to 613 in 1931 and 1,628 in 1935[33].

To regard to puddled iron, it is interesting to highlight how the Araya mill could continue making this product when other ironworks with similar characteristics had to stop production. The main explanatory factor here can be found in the commercial policy of the company, which from 1907 operated as a free rider in a market cartelised by the *Central Siderúrgica*. From at least 1871, Spanish ironworks had cartels to fix prices and conditions of sale, with the most important being the *Central Siderúrgica*, which operated from 1907 until 1968[34]. This organisation not only set prices and sale conditions, but also regulated the distribution of a good part of the iron and steel production through a sales office in Madrid that received the orders and distributed them among the members of the cartel. Initially, the *Central Siderúrgica* favoured large customers (especially large iron wholesalers) over small customers, offering them better conditions. But, from 1928, it pressured its main customers into signing agreements which obliged them to make all their orders from steelworks in the cartel[35]. At the same time, and in an attempt to rationalise the dispersed Spanish market, the rules of the cartel stipulated that members could not take orders from customers that did not buy a minimum of 450 tonnes per year of merchant bar iron.

The owners of the Araya mill, which had traditionally participated in these agreements, decided not to join the new cartel because they considered their quota of 1.75% of sales to be too low. Acting as a free rider until 1936, Araya was free from the restrictions imposed by the cartel on the other ironworks still making puddled iron. This allowed them to continue supplying very small segments of the market in which wrought iron was still highly valued because it was easily soldered and forged, which meant that rural forges making and repairing agricultural tools were their main customers. In this way, the drop in sales in the more dynamic markets, in which the Araya iron was pushed out by the competition from the steel sold by the *Central Siderúrgica*, was compensated by the increased rural demand from inland regions.

Additionally, the owners of the company went further than just maintaining this demand; they also sought new markets, using one of the main advantages of wrought iron over steel: its non corrosive quality. This characteristic converted puddled iron into a very suitable product for applications that needed particular resistance to oxidation, such as the shipbuilding. For this reason, in 1936, the Ajuria mill asked *Lloyd's* to certify the quality and suitability of its products for the

[33] Sáez García (1999).
[34] Sáez García (2005).
[35] See Martínez Ruiz (2004) for the relations between iron wholesalers and Central Siderúrgica until 1936.

manufacture of the rivets used in shipbuilding to join the ship plates. Once they had acquired the quality certificate, they registered a commercial trademark that allowed them to differentiate their puddled iron products. This product differentiation strategy was successful as, once the Civil War was over (1936-1939), the puddled iron rod used for rivets became one of the firm's main products, and continued to be so until shipbuilders started joining ship plates through soldering.

In summary, the fact that it was the last company still using traditional technology allowed the Araya ironworks to find niche markets in which the characteristics of wrought iron and charcoal pig iron were highly appreciated. Moreover, in the absence of competition, these products fetched higher prices in the market than common steels and coke pig iron. The Araya mill never tried to produce steel through technologies such as the Bessemer converter or the open-hearth furnace, in which the Asturian and Biscayan producers had a clear advantage with their cheaper inputs, thanks to their vertical integration strategies and their proximity to the mines. However, it was successful in its strategy of finding profitable niche markets, adopting appropriate technology and diversifying its production.

3. The rise and fall of a business dynasty

During the period analysed, the Ajurias were not just content to keep the family firm going. The availability of financial resources -thanks to the large profits made by the company around the turn of the century and the World War I- and human resources not only allowed them to improve the ironworks, but also to expand the family's business concerns. This investment activity was especially prevalent in the period between 1890 and 1914, i.e. with the third generation. On some occasions, these investments were made individually by different members of the family, but before 1917 the usual practice was to use the reserve of their firm *Viuda de Urigoitia e hija*. During the period from 1891 to 1914, the company's profits were 5.2 million pesetas, of which 1.7 were retained by the two owners, 0.2 were given to the managers (the Ajuria brothers) and 3.3 were used to increase the share capital. A good part of this final sum was used to buy shares and bonds of various industrial companies, so that by 1917, the firm portfolio had reached a value of 2.1 million pesetas.

These investments were often in new business initiatives, the most important being the creation of *Ajuria y Aranzábal, S.A.* in 1914 (*Ajuria, S.A.* from 1927), which became the most important agricultural machinery manufacturer in Spain[36]. The Ajuria brothers were the main shareholders of the company and provided most of the capital for the successive capital increases. Similarly, they occupied the main management posts of the firm until the mid 1930s. Carlos Ajuria was the Chairman of the board of directors until his death in 1935 and his brothers Francisco and Serafín sat with him on the board. Serafin was the lifeblood of the business and its managing director, remaining in the

[36] Chief among the other Ajuria family industrial initiatives was their participation in metallurgy companies (*La Iberia* and *La Camera Española*) and the food and agriculture sector (*Azucarera Alavesa*).

position until he died in 1937. Another brother, León Ajuria, managed one of the company's factories[37].

The prosperity of their businesses gave the Ajuria family great wealth and esteemed social status. Their social influence developed into strong political activity. Carlos Ajuria was president of Álava Council (the most important local political body) between 1901 and 1905, and a member of the Spanish Senate between 1910 and 1925. His brother Serafín was, without doubt, one of the most influential characters in local politics. Although he only held public positions between 1923 and 1929, he had great control over local institutions from 1923 until his death in 1937.

The entrepreneurial spirit of the Ajuria family appeared to run out in the mid 1930s with the deaths of Carlos and Serafín Ajuria. In 1944, *Ajuria y Urigoitia*, the company name under which the Araya ironworks operated, became a public limited company due to the splitting up of the ownership when the fourth generation was incorporated. The control and ownership of the company remained in the hands of the Ajuria family, although disagreements among them led to its sale to a Kuwaiti group in 1959[38]. After the 1970s financial crisis, the activity of the firm was very irregular until its final closure in 1985.

With regard to the other family business, the agricultural machinery company *Ajuria, S.A.*; from the mid 1930s, the main management posts were filled by people from outside the family, although the Ajurias retained their decision making capacity. After strong growth until the end of the 1960s, the company went through great financial difficulties, along with a significant reduction in sales leading to its disappearance in the 1970s[39].

Conclusions

The San Pedro de Araya mill makes a good example of ironworks that, as a consequence of their geographical position and their available natural resources, could not guarantee the successful adoption of the new iron and steel processes introduced from the mid 19th century. These companies found themselves channelled into sticking to a model characterised by the use of charcoal in smelting and the puddling technique in refining. Despite the growing competition from new technologies, the traditional model coexisted alongside them for several decades. This is not an unusual situation. As shown by Rosenberg (1976), as opposed to the widespread idea that the processes of technological

[37] The strategy followed by the Ajuria family is similar to the strategy described by Nenadic (1993) for small family firms in Edinburgh. According to this author, the creation of new companies offered a way out for the younger members of the family while allowing business expansion outside the family firm without risking the main source of family income.

[38] As recently shown by Colli (2003), p. 14: "The problems of leadership succession arise where the family is not able to produce adequate leaders to take over the entrepreneurial role or, on the contrary, where too many of them are involved in the day-to-day management of the company". Although in our case, the information available does not give us the exact reasons why the Ajuria family withdrew from the business, it seems clear that it was due to the absence of clear leadership among the members of the fourth generation. It is important to point out that this problem is not exclusive to family firms, but that is common in non-family companies in which the management rests on the same person over many years. Valdaliso and López (2000), p. 387.

[39] The demise of *Ajuria, S.A.* came in the context of a general crisis that affected the agricultural machinery manufacturing sector in Spain from the mid 1970s and led to the disappearance of practically the whole sector. The fundamental cause of this crisis was the lack of technical capability of the Spanish factories to begin production of the new goods demanded by the Spanish agricultural sector, tractors and, to a lesser extent, harvesters. Martínez Ruiz (2005).

change consist of the rapid substitution of old technology for new more efficient technology the usual situation is often precisely the opposite: the coexistence over decades of the old and new techniques.

Until the end of the 19th century, puddled iron was able to resist the competition of steel for two reasons: firstly, the improvements introduced in the puddling furnaces that gave significant fuel consumption savings; and secondly, the greater malleability of puddled iron, which meant that in certain applications it could not be replaced by Bessemer or acid open-hearth steels. Institutional factors such as the tariff protectionism and the cartelisation of the market also played an important part in the continued existence of ironworks still producing puddled iron until the beginnings of the 20th century. The competition from steel was fully felt from 1905, due to the price war unleashed by the breakdown of the iron and steel cartel and the growing competition from basic open-hearth steels, with very similar qualities to puddled iron which, therefore, could replace it in most applications.

Until the Civil War (1936-1939), the only company that had successfully adopted the new mass production technologies in Spain was the giant of the sector –in national terms, given that its dimensions were modest in world terms-, *Altos Hornos de Vizcaya*, created in 1901 by the merger of three large mills situated in the Bilbao area. The rest of the ironworks combined the production of iron and steel bars, a market clearly dominated by *Altos Hornos de Vizcaya* from 1907, with the search for profitable niche markets and the adoption of technologies suitable for this purpose. In the search for specialisation paths, the traditional family firm proves to be at least as efficient as companies adopting management styles more akin to those of large companies[40].

In this sense, what happened in Spain is not at all anomalous and is very similar to the case of the independent iron mills in Pittsburgh, described by Ingham (1991). The small and medium sized companies in Pittsburgh were successful when they adopted a strategy based on the search for new specialized markets that could be serviced by small production runs of specialty iron and steel[41]. Conversely, they failed when they tried to fight the sector giant, A. Carnegie's *Edgar Thomson Works*, with its own weapons, i.e. through the adoption of Bessemer converter and mass production[42].

In the case of Araya, one of the key points that allowed them to successfully face this period of change was the successful succession carried out by León Urigoitia. Despite the difficulties he met in the succession process, due to the death of his son Serafín, who had been named as the successor to the head of the company, the training given to the third generation enabled them to confront the rapid technological changes in iron and steelmaking without having to appoint professionals from outside the family. The Araya case shows that, as pointed out by Zeitling (2003), at a given moment "multiple efficient combinations of capital equipment, factor supplies, and human resources are typically possible"[43]. This was demonstrated by the strategy followed by Alfredo and Carlos Ajuria, which had two aspects. First, they opted to find refuge in profitable niche markets where the particular properties

[40] Another well known case of a family company in the iron and steel sector, studied by Alonso, Erro and Arana (1998), is *Santa Ana de Bolueta* which, through specialisation and niche markets, has managed to survive to this day.
[41] Ingham (1991), p. 84.
[42] This was the case of *Pittsburgh Bessemer Steel* and of the *Duquesne Steel Company*. Equipped with the most modern machinery for producing Bessemer shaped steel, they challenged A. Carnegie in the 1880s and ended up being taken over by him a few years later. Ingham (1991), pp. 60-73.
[43] Zeitling (2003), p. 64.

of charcoal pig iron and puddled iron were still highly appreciated. Second, they sought alternatives to the traditional technological pattern, with a special mention for their early use of the electric furnace, which did not have the desired success due to the scare water resources in the area, preventing greater production of iron alloys, the final end use given to this new technology. Ultimately, it was a strategy directed at diversifying production without leading to specialisation, which allowed them to spread risk and compensate for the fluctuations in the demand for different products. Hence, in the crisis of the 1930s, the sharp fall in sales in the most common shaped iron was partially compensated by the production of ferrosilicon in the electric furnace, making the firm's losses less important than those of the rest of the sector.

With regard to the slump in the industrial activities of the Ajuria family in the mid 20th century, it is difficult to identify a clear cause. The difficulties of the agricultural machinery business appeared to be mainly linked to problems derived from the growing openness of the Spanish economy and the failure of the whole sector to adapt to the new needs of agriculture. In contrast, the abandonment of the iron and steel business could be more closely linked to the multiplication of the owners with the incorporation of members of the fourth generation[44].

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[44] What happened to the Ajuria family businesses is similar to the cases of other Spanish family firms described by Fernández Pérez and Puig (2004). According to these authors, during the 20th century, some of these companies, which were closely linked to protected domestic markets and had successfully applied innovations in production, were reluctant to apply new management methods, which could have been the origin of their failure.

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