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Working Paper nº 04/07

Sustainability of Collusion: Evidence from the Late
19th Century Basque Iron and Steel Industry

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Working Paper No.04/07

June 2007

JEL No. L13, L41, N84

Keywords: market power, collusion, iron and steel industry

ABSTRACT

This paper presents evidence on actual collusive agreements from the late 19th Century iron and steel industry in Spain. We examine the minutes of the executive boards of two Basque firms, Altos Hornos de Bilbao and Vizcaya, to discuss the relevance of different factors on survival and failure of a number of explicit collusive agreements reached in the industry from 1886 to 1901. We find that collusion was more likely to break down in periods of falling demand, and that strong demand provides these agreements with stability. Additionally, we argue that the presence of centralized sales agencies, similar degrees of vertical integration among colluding firms, and tariff protection are factors that facilitate collusion.

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ACKNOWLEDGEMENT

We thank Rafael Torres for his valuable comments on previous versions of this paper. Financial support from Ministerio de Educación y Cultura (SEJ2006-10087) and PIUNA is gratefully acknowledged. All errors are our own.

1 Introduction

Spanish production of iron and steel production in the late 19th Century was mostly concentrated in the Northern regions of Asturias and the Basque Country. Following discoveries of phosphoric iron ore in the Basque province of Biscaya, the production of iron and steel in this region quickly increased in the 1870s and 1880s and became Spain's most active region, see Houpt (2002). The final years of the 19th Century were characterized by alternating episodes of competition and collusion among the most important producers, until Altos Hornos de Vizcaya (hereafter AHV) emerged as the dominant firm in the industry in 1901 as a result of the merger of three Biscayan producers of iron and steel: Altos Hornos de Bilbao (hereafter AHB), Vizcaya, and Iberia. AHV was to become the leader in the Spanish market throughout most of the 20th Century.

The purpose of this paper is to highlight the most important factors that facilitated the survival of collusive agreements in the iron and steel industry, or, to the contrary, those that caused their dissolution. In particular, this paper studies the set of collusive agreements in which AHB and Vizcaya took part between 1882 and 1901. This is the time span that ranges from the foundation of AHB and Vizcaya to the merger that led to the foundation of AHV. Evidence is taken from the minutes of the executive boards of AHB and Vizcaya. These documents reflect the decisions made by managers of both firms, providing information on the reasons for such decisions. Hence, our data allow us to focus on some features of collusive agreements that have been overlooked by tacit collusion models, and yet are clearly relevant.

An interesting feature of this period is the lack of antitrust law to prevent and prosecute collusion. More to the contrary, colluding firms practiced explicit, rather than tacit collusion. Precisely because this lack of antitrust legislation, minutes of the meetings of the managerial boards of the main firms involved in the collusive arrangements provide complete evidence on the strategic considerations and arguments related to the establishing, operation and also the ceasing of different collusive arrangements.

If a collusive agreement, tacit or explicit, is to be sustainable, it has to satisfy the parties' incentive compatibility constraints, otherwise the parties will abandon cooperation. Changing circumstances, or perverse incentives provided by the contract itself, may prevent the incentive compatibility constraints from being satisfied. In this sense, these agreements have a self-enforcing range, where it is in the parties' interest to continue cooperation, see Klein (1996). As soon as at least one of the parties finds itself outside of this self-enforcing range, cooperation is likely to break down. These situations occur, for instance, after changes in legislation, demand, or degree of vertical integration. We will later verify that most of the times collusion broke down not following an individual deviation from the collusive agreement, but rather because either the initial arrangement was poorly designed, or after a change in the environment, such as a decrease in demand.

The theoretical literature on Industrial Organization uses game theoretic arguments to describe the forces behind collusive agreements, emphasizing that

the success of a collusive agreements requires repeated interaction that allows firms to punish individual deviations.¹ This way, cooperation may be sustained even if the one-shot equilibrium involves no cooperation, such as in the simple prisoners' dilemma game.

In their seminal paper, Green and Porter (1984) propose a model where price wars, but not deviations, are observed in equilibrium. In a setting of imperfect information, reversion to competitive pricing is triggered by firms facing unexpectedly low demand, to later return to collusive pricing. This model predicts that no cheating occurs and price wars are part of the collusive equilibrium, and is tested in Porter (1983), using data on freight rates posted by firms affiliated to the Joint Executive Committee in the 1880s. By contrast, Rotemberg and Saloner (1986) predict that prices will be countercyclical because in booms, defined as a high-demand period followed by some low-demand periods, incentives to cheat are highest, which calls for price reductions. Ellison (1994) tests these models using the same dataset as in Porter (1983) to find that the empirical results are more supportive of Green and Porter's model, although this author also acknowledges that the existence of cheating can not be ruled out. Our paper complements this literature by analyzing the actual causes of collusion breakdown, as recorded in the memoranda of the management boards of colluding firms. This information is complementary to prices and quantities observed in Porter (1983) and other articles based on this one.

Our approach is in line with the research presented by a series of papers in the literature on economic history. Carlos and Hoffman (1986) and the follow-up comment by Nye (1988) took a close look at the North American fur trade in the early 19th century. They argue that strategic considerations, in particular a bargaining game under incomplete information between the two companies, determined market structure as in spite of the mutual benefits of collusion or a merger the firms were engaged in intense conflict. The merger then eventually took place, but by that time economic rents had disappeared. Barbezat (1989) and Peters (1989) report historical evidence on the International Steel Cartel of 1926 and the Rheinisch-Westphalian Coal Syndicate before World War I respectively. They point out that due to the numerous difficulties of achieving collusive behavior, i.e. the presence of disintegrative forces such as individual interests, cheating, heterogeneous products or dynamic market conditions, the intents to completely eliminate competition among members did not succeed. However, these problems did not hinder cooperation or partial success. The International Cartel did limit trade among its members and allowed for the formation of domestic cartels, and also the German Coal Syndicate did operate for over two decades. Finally, our paper is closely related in its philosophy to Genesove and Mullin (2001) who take a normative approach in the sense that they "uncover puzzles for established theory, and identify elements that a richer theory should encompass". The examination of the Sugar Institute formed in 1927 shows the importance of communication in the operation of a cartel. In particular, individual deviations or cheating were discussed in the regular meetings. Pun-

¹Check, for example, Mas-Colell et al. (1995) for an introduction.

ishment did not mean reversion to competitive conditions as suggested by many theoretical model, it rather included a tailor-made solution to the problem at hand.

Empirical results from the experimental laboratory also help us to better understand the forces behind collusive agreements. Due to the large gap between naturally occurring markets and theoretical models of industrial organization, laboratory experiments offer a convenient testbed for checking theoretical predictions and also suggest ways of improving them.² The main result on competition in quantities with more than two firms in the lab is that the observed outcome is more competitive than the theoretical prediction. In case of duopolies experimenters report data actually consistent with both extreme results: from perfect collusion to fierce competition. Repetition has been observed to decrease cooperation in single-period market games in the laboratory. In multiperiod games, repetition with the same cohort and with previous cohorts has been observed to increase cooperation. These results are in line with the intuition according to which repetition with the same cohort helps to establish trust and a reputation for punishing individual deviations. Punishment strategies play an important role of keeping up collusion both theoretically and empirically. While with two firms a defector can be punished without harming a cooperative third party, with more players direct punishment may be necessary to enhance cooperation. The effectiveness of nonbinding communication in maintaining collusive behavior, though intuitively very important, seems to depend on the market institution implemented in the lab.³ Finally, Abbink and Brandts (2006) reports experimental data on duopolies in the lab showing that collusion is almost three times as frequent in shrinking markets as in growing ones, moreover prices are more than twice as high.

In line with previous theoretical arguments and empirical findings, the evidence discussed in this paper suggests that demand fluctuations are indeed play a crucial role in the sustainability of collusion. Specifically, collusion is likely to break down in the presence of a declining demand, but an extended period of depression induces firms to seek collusive arrangements. However, we also identify other determinants of the sustainability of collusive agreements. In particular, higher tariff protection, the presence of monitoring institutions, and colluding firms having similar degrees of vertical integration facilitate the survival of collusive agreements. We will argue that these factors are indeed relevant, and call for an enriching of existing models of collusive behavior, especially if they are to be adapted to a setting where collusion was not illegal but in some cases even encouraged by governments.

The paper is organized as follows: Section 2 presents the historical back-

²This part on experimental research in industrial organization is based on Holt (1995).

³Competition among price setting firms has been the objective of several experimental studies. For example, Dufwenber and Gneezy (2000) study collusion in a static framework and find that prices exceed marginal cost for the case of two firms, but are equal in the case of three and four. Experimental studies on quantity competition provide similar conclusion. In a recent survey of the literature Huck, Normann and Oechssler (2004) argue that while duopolies sometimes manage to collude, collusion is very difficult with more than three firms on the market.

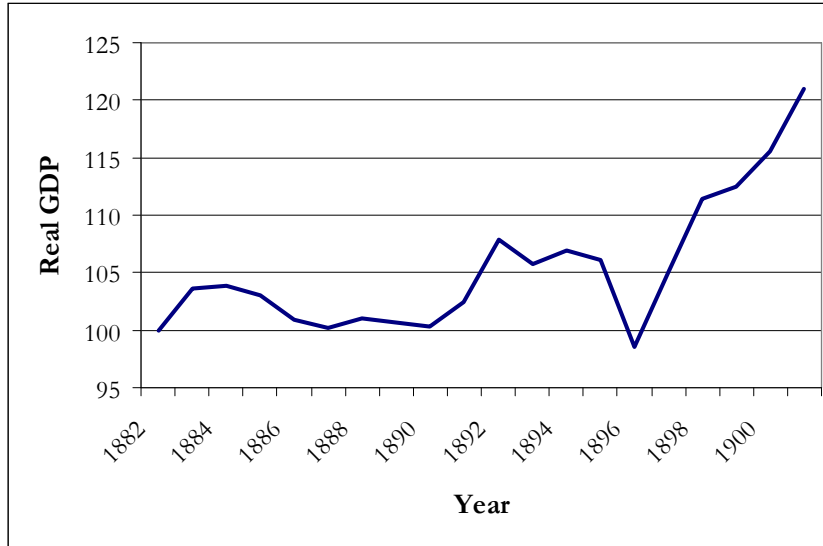


Figure 1: Spanish real GDP, 1882-1901. Base year 1882=100

ground, section 3 presents and discusses the different collusive agreements reached throughout the final decades of the 19th Century, whereas section 4 concludes.

2 Historical background

This section presents a brief discussion of the economic conditions of the Spanish economy in late 19th Century, as well as an overview of the Spanish iron and steel industry, including a summary of the history of AHB and Vizcaya.

2.1 The economic environment

The Spanish economy in the late 19th Century was characterized by two distinctive features: recession and a turn towards protectionism. The 1880s and 1890s witnessed a depression of agriculture, which was common to other European countries. Carreras and Tafunell (2003) argue that this crisis in agricultural production was a consequence of the increase in the global supply of agricultural products, especially because of the increase in arable land in North and South America. Given the relevance of the primary sector in the Spanish economy at that time, well over 50% of total output, crisis in this sector implied a feeble demand for industrial products. Figure 1 shows the evolution of Spanish GDP from 1880 to 1901, where data have been obtained from Carreras and Tafunell (2003). Real output was flat through most of the period considered, with some years of negative growth until 1896, when output began its recovery.

Regarding tariff protection, Spain was not an exceptional case in the general turn towards protectionist policies adopted by most European countries in the late 19th Century. Indeed, protectionist tariffs were adopted in Germany, France, Austria, Italy and Russia, see Bairoch (1989). In the case of Spain, the 1869 Tariff provided relatively low protection, and it was in effect during the 1880s. However, after several modifications of the 1869 Tariff, a new protectionist tariff was introduced in 1891.

The turn towards protectionism can be seen as a result of economic depression and a reaction towards protectionism in neighboring countries. However, it is also necessary to keep in mind the relevance of lobby groups in the design of the Spanish tariff policy in the late 19th Century and early 20th Century. In particular, the influence of the domestic iron and steel industry in the choice of tariff protection was unquestionable. These producers enjoyed higher protection after the 1891 Tariff, the removal of the exemption from tariff duties of railways materials in 1896, and the 1906 Tariff. Furthermore, protection was greater the more elaborate products were. Indeed, the tariff on pig iron ingot did not change with the passing of the 1891 Tariff Act, and it remained fixed at 24 pesetas per ton.⁴ By contrast, protection on finished iron and steel products greatly increased in the 1891 Tariff. Producers of finished products were precisely the customers of firms such as AHB and Vizcaya: protection on these products ultimately allowed producers of iron and raw steel to raise prices.

The depreciation of the Spanish peseta throughout the 1890s provided additional protection for the domestic industry. This way, Spanish producers of iron and steel were able to charge prices close to the monopoly level without prompting imports, given the combined protection of high tariffs and depreciated peseta. Figure 2 shows the evolution of the exchange rate peseta-pound from 1880 to 1901. Of special interest is the year 1898, where a maximum of 46.7 pesetas per pound was reached in June.

2.2 The iron and steel industry

The technological changes during the 1880s such as the introduction of Bessemer and Martin-Siemens converters, implied a fundamental shift in the structure of the steel industry and also boosted the industrialization of the Spanish economy overall.⁵ The production of Spanish iron jumped from 69,149 tonnes per year in 1876-80 to 184,600 tonnes per year level in 1886-90. The productivity of firms that adopted the new technology increased considerably and many smaller factories disappeared. The market for iron and steel products in the final years of the 19th century was characterized by the recession of 1890-92 and the recovery starting in 1896. Due to the fierce competition and the decreasing price level the number of firms in the steel industry fell from 54 in 1880 to 15 in 1896. For example, during the final five years of the 19th Century three firms, AHB, Vizcaya and San Francisco de Mudela, produced 78% of the iron ingot in Spain.

⁴The price of pig iron fluctuated between 55 and 105 pesetas between 1886 and 1901.

⁵This section summarizes the history of the Spanish ingot cartel during the period 1880-1904 based on González Portilla (1985).

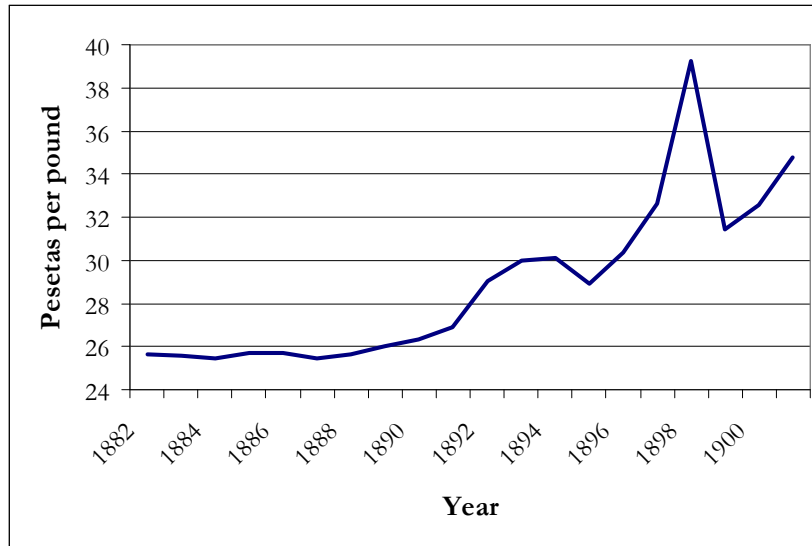


Figure 2: Spanish pesetas per British pound, 1882-1901

Finally, in 1897 the total production of iron and steel in Spain was regulated by syndicates and/or bilateral agreements across producers.

Sánchez (1945) lists the main producers of iron and steel products that were active in Spain at the end of the 19th Century. These were concentrated in the Northern regions of Asturias and the Basque Country. There were three main producers of pig iron and steel in Biscay: AHB, Vizcaya, and San Francisco. Their respective capacities were 100,000, 120,000, and 36,000 tonnes of ingot per year. In contrast to AHB and Vizcaya, San Francisco did not transform pig iron into steel. In addition to these producers, there were a number of firms devoted to the transformation of iron and steel into more elaborated products such as tinsplate, wire, or nails. Three works were located in Asturias: Duro y Compañía, Mieres, and Moreda y Gijón, with capacities 30,000, 24,000, and 16,000 tonnes of ingot per year. Duro y Compañía and Mieres transformed pig iron into steel using Martin-Siemens converters.

2.3 AHB and Vizcaya: the early years

This subsection follows González (1985) in providing a description of the investments undertaken by AHB and Vizcaya in their early years, as well as on the type of technology used in the production of steel. AHB (Altos Hornos y Fábricas de Hierro y Acero de Bilbao) was established in 1882 as the result of the acquisition and reform of two obsolete works, namely “Nuestra Señora del Carmen de Baracaldo” and “Nuestra Señora de la Merced de Guriezo”, both of them belonging to the Ibarra and Cía. Company. The initial equity was

12,500,000 pesetas, divided into 25,000 shares. The purpose of the works was, as stated in the first meeting of the Board of Governors, to develop in Spain a competitive Bessemer and Martin-Siemens steel making industry. After considering where in Spain the location of the works would be more profitable, Biscay was chosen, because of its easy access to non-phosphoric iron ore, essential in the Bessemer process. In particular, AHB signed a contract with Orconera and Franco-Belga mining companies for the supply of ore at 7 pesetas per ton. The initial capacity of the blast furnaces was 70,000 tonnes of pig iron ingot in 1883.

AHB was granted in 1886 the exclusive right to use the Bessemer process in Spain for five years. Windsor Richards, who was director of the Bolckow, Vaughan and Co. factory in Middlesbrough, one of Britain's largest works, was hired as a consultant to supervise the production of iron and steel. The factory was organized in three different sectors: the two blast furnaces, the Bessemer converters and the transformation sector. A Martin-Siemens converter started complementing the Bessemer facilities in 1888. In the following years, the factory undertook investments to integrate forward into the production of steel plates and backward into the production of coke.

Vizcaya (Sociedad Anónima de Metalurgia y Construcciones Vizcaya) was also founded in Bilbao in 1882. Its initial stockholders were Basque entrepreneurs related to mining and mercantile activities, and represented a more homogeneous group of interests than those of AHB. Vizcaya's equity was initially set at 12,500,000 pesetas, divided into 25,000 shares. A brand new plant was built, using Belgian technology. The reason for this choice was that both Benigno and Víctor de Chávarri, two of the founders of the society, had studied engineering in Liege. In June 1883 and December 1885, blast furnaces number one and two, respectively, were operative. Vizcaya procured iron from the perpetual rent of the several mines, and Vizcaya undertook a number of investments to integrate backward into the production of coke.

Regarding the production of steel, Vizcaya installed in 1887 three Martin-Siemens converters, so as to begin the production of steel, as well as facilities for the transformation of steel into more elaborate products. In 1889, a fourth Martin-Siemens converter was built, together with other auxiliary facilities. The production of steel was started in April 1889, and in March 1891, the firm began production of rails using "Robert" converters, which did not use scrap to produce steel, as opposed to the Martin-Siemens process. In 1891, four puddling furnaces were installed, and a Siemens-Harvey furnace was operative. With these investments, the capacity of the firm was 60,000 ton. of steel and 3,500-6,000 of puddled iron per year.

Vizcaya was intensely devoted to the production and sale of pig iron early on, both in the domestic and in the foreign markets. Actually, from the very beginning this firm sent commercial representatives to Western Europe and the US. The consequence was a high proportion of ingot sold abroad, more than 50% in the early years of the firm. In 1886-91, 69% of the pig iron ingot sold was exported. Italy was the most important market for Vizcaya's production of ingot, with several important contracts signed with the Terzi factory in 1888-89, despite the protectionist Italian tariff of 1887.

This focus changed after 1891, when the protectionist tariff was passed. Vizcaya started focusing primarily on the Spanish market, which now became protected from the outside competition, as the unit profit in steel production was higher than that coming from the sale of ingot, especially abroad. However, the fact that the Spanish market for steel products was in a recession up to 1896, lead to an inefficient production, below capacity in all cases.

3 Competition and collusion, 1886-1901

The purpose of this section is first to describe the evolution of collusive arrangements where AHB and Vizcaya were active players, before they eventually merged to create Altos Hornos de Vizcaya in 1901. The second goal is to discuss the relevance of different factors that might facilitate collusion or cause the dissolution of cartel agreements. It will be argued below that there were several factors behind the collapse of collusive arrangements, and that there was not a common reason to explain the failure of all the collusive agreements analyzed.

AHB and Vizcaya started making efforts to reach agreements so as to restrict competition in the industry very early on. Indeed, the first collusive agreement was initiated in 1886, merely four years after AHB and Vizcaya were founded. Table 1 provides a brief summary of all the arrangements that took place between 1886 and 1901 and that included AHB and/or Vizcaya. The table displays information on cartel participants, scope, and duration.

Duration	Scope	Participants
Feb 1886 - Jan 1888	pig iron	Vizcaya, AHB, San Francisco
Mar 1889 - Jun 1891	iron and steel products	AHB, Felguera, Mieres, Moreda, Vizcaya (1890)
Jan 1893 - May 1896	iron and steel products	Duro, Mieres, Moreda, Vizcaya, AHB + others (1896)
Jul 1894 - Dec 1903	pig iron	Vizcaya, AHB, San Francisco (1895)
Feb 1896 - 1900	rails and other products	Vizcaya, AHB
Feb 1897 - 1904	iron and steel	Duro, Mieres, Moreda, Vizcaya, AHB + others

Table 1: Collusive arrangements in the Spanish iron and steel industry, 1886 - 1901

The table shows that the scope of the arrangements was initially limited to the market for pig iron, since Vizcaya would not start production of steel until 1890. Collusion gradually extended throughout the 1890s to include most iron and steel products, and included not only the Biscayan producers, but also Asturian producers such as Duro, Felguera, Moreda and Mieres. Indeed, the 1897 agreement meant the almost complete cartelization of the Spanish iron and steel industry, which were to persist throughout most of the period to 1936. After the merger between AHB and Vizcaya in 1901, the resulting firm, Altos Hornos de Vizcaya (AHV), became the unquestionable leader in Central Siderúrgica, a centralized sales agency, and AHV firm was also to become a

member of a number of international steel cartels.

3.1 Demand stability and non-members' pressure

Fluctuations in the level of demand have received close attention as a crucial factor determining the sustainability of collusion. Green and Porter (1982) predict that, in the presence of unobservable demand shocks, unexpectedly low demand levels trigger price wars. These price wars are part of firms' strategy to sustain a given collusive outcome, and thus, they should be observed in equilibrium. By contrast, Rotemberg and Saloner (1986) argues that if a high-demand period is to be followed by a low-demand period, the incentives of firms to deviate from collusion are highest, unless firms adapt the collusive terms to demand conditions, for example by introducing countercyclical pricing. Furthermore, there is also extensive evidence that many collusive agreements are initiated during recessions. In this case, the prospect of several periods of low demand induces firms to seek understanding in the form of reduced sales.

In addition to fluctuations in demand, if a cartel does not include all firms in the industry, competitive pressure from these outsiders may be a factor that introduces instability in the agreement. Non-member firms benefit from high prices imposed by the cartel. If the combined capacity of these firms is small relative to that of the cartel, its members may take this behavior as given, acting collectively as a dominant firm. This is likely to be the case in high-demand periods. However, in the presence of a declining demand, competition from non-members introduces further reduces the effective demand for the cartel, which calls for a modification of quotas and/or prices. These modifications introduce disputes among cartel members, which the likelihood of collusion breakdown.

Falling demand and the behavior of firms not included in the cartel was clearly a factor behind the breaking down of the iron and steel products cartel in 1891. This agreement was initially signed by AHB together with three works located in Asturias: Felguera, Mieres, and Moreda.⁶ Vizcaya joined the agreement only in 1890, once its steel converters became operative. Before entering the cartel Vizcaya pursued an aggressive pricing strategy so as to gain market share, given its high installed capacity and its novelty in the market for steel. However, Vizcaya started production of steel in the midst of a recession, and its presence outside of the cartel endangered its very stability. Indeed, the cartel was about to be finished in June 1890 because of competition from Vizcaya, and Vizcaya then joined precisely as a way to temporarily keep the agreement alive.

The entering of Vizcaya into the agreement called for a redesign of market shares, which generated discrepancies among cartel members, which were aggravated by the falling domestic demand. The agreement was not to last long, and it was precisely Vizcaya the one that chose to stop cooperation. The reason given was the need to react against competition from firms not adhered to the cartel, which were selling at prices below those set by the cartel. Whereas this

⁶References: Libro de Actas del C. de A. de AHB, tomo 3, 1887-89, pp. 173, 177, 8 de marzo de 1889. Libro de Actas del C. de A. de la Vizcaya, tomo 3, p. 213, 10 de julio de 1890.

would have been less of a problem in an environment of growing demand, in a low-demand setting, this clearly endangers survival of the agreement: cartel members realize sales well below the expected level, which may lead towards inefficient proportion and even financial distress. Hence, the combination of low demand and competition from non-members caused dissolution of the iron and steel products cartel in 1891⁷.

3.2 Alignment of interests and multimarket contact

The probability of sustainable collusion increases with colluding firms' similarity in cost structure, degree of vertical integration, and the number of markets where they are simultaneously active. Industrial Organization models typically assume that colluding firms are homogenous, although this was far from true in the case that we are analyzing. On the other hand, the simultaneous presence of colluding firms in different markets increases the probability of collusion, since deviation in one market prompts retaliation in every market, see Bernheim and Whinston (1990).

Different degrees of vertical integration created a divergence of interests among colluding firms in the 1886-88 pig iron cartel. The fact that AHB was integrated into the production of steel while the remaining firms in the cartel were not were a source of conflict, which ultimately led towards the dissolution of the cartel. After the first attempts in 1885, the cartel (Syndicate) was finally born in February 1886 including Vizcaya, San Francisco de Mudela, and AHB, and following the example of the German steel industry.⁸ Vizcaya and San Francisco de Mudela, produced almost exclusively ingot, although AHB was about to begin the production of steel, using Bessemer technology.

The collusive arrangement specified fixed market shares for cartel members, and there was a system of penalties and compensations for production exceeding or falling short of assigned shares. Prices were set by the Syndicate, which managed orders received by member firms, and had the exclusive right to alter prices. The agreement was extended to international sales in March 1886.

The problem with this agreement, and the reason why it ultimately broke down, was that AHB had the incentive to devote most of its production of pig iron to the production of steel. Hence, the Syndicate had to reject some orders, and AHB consistently produced below its share, which meant that AHB was a net receiver of compensation payments from the other two firms. With Vizcaya considerably increasing its production capacity, and given the fixed shares for the domestic market, Vizcaya could only use its excess capacity on the much less profitable foreign market. This market was subject to increased protection: for instance, Italy, which absorbed a sizeable amount of production from Vizcaya, raised tariffs in 1887. Thus, the initial design of the cartel agreement

⁷Libro de Actas del Consejo de Administración de la Vizcaya, tomo 3, p. 309. June 12, 1891.

⁸References: Libro de Actas del C. de A. de la Vizcaya, tomo 1, 1882-86. Sesión del 15 de febrero de 1886, pp. 273-275; 27 de febrero de 1886, p.177; 4 de marzo de 1886, p. 280; 19 de marzo de 1886, p. 290.

greatly benefited AHB, since it ensured a constant flow of revenues through the sale of ingot or compensation by other firms in addition to sales of steel, which remained excluded from the agreement. Vizcaya realized about this perverse effect, and repeatedly tried to renegotiate its share in total sales. Indeed, Vizcaya demanded at least a 50% share in total sales in January 1888, right before the Syndicate was dissolved. Hence, in this case the main reason for the breaking down of collusion was differences in degree of vertical integration among cartel members. These differences generated a perverse incentive on AHB's side to take advantage of the terms of the agreement, which ultimately led towards the dissolution of the cartel.

In this line, AHB's refusal to lower prices of pig iron was cited as one of the reasons given by Vizcaya to quit the cartel. Since AHB was integrated into the production of steel, it was in this firm's interest to keep the price of iron ingot high, to raise the cost of competitors in the market for steel products. This caused Vizcaya to produce at an inefficient scale, well below capacity, an effect that is aggravated if foreign markets are becoming more protected. AHB's reaction to Vizcaya announcing that it would no longer support the syndicate was to close one of its blast furnaces: AHB expected a period of low prices of pig iron ingot, rendering its production uneconomical. This suggests that indeed AHB was actually taking advantage of the Syndicate, obtaining extra revenues from sales of pig iron.

In contrast to the previous decade, Vizcaya and AHB produced a similar range of products in the 1890s, and were mainly targeting the domestic market, especially after the passing of the 1891 Tariff Act. As it was pointed out above, the gradual increase in tariff protection in Spain as well as in foreign countries that were markets for Vizcaya's production induced this firm to focus on the domestic market. Recall that from the very beginning, AHB had a greater interest in the domestic market. Most of AHB and Vizcaya's business in the 1890s consisted on supplying independent producers of steel products, and they had an interest in sustaining high steel prices. Hence, the interests of the two firms became more aligned in the final decade of the 19th Century. Indeed, no collusive agreement was signed after 1890 where one of the two firms, but not the other, was present.

Similar degrees of vertical integration also meant that both firms were simultaneously present in a large number of markets. Multimarket contact is expected to be a factor that facilitates collusion, since deviation in one market should prompt retaliation in every market. This should in principle explain the ever-growing number of collusive agreements where AHB and Vizcaya were present, and the greater stability of these agreements throughout the 1890s. However, it is striking to observe that actual practice does not exactly fit what the theory predicts, in particular the behavior of firms following the ceasing of a cartel agreement. For instance, even as Vizcaya announced its exit from the 1889-91 cartel that also included AHB and Asturian producers of iron and steel, it communicated AHB its willingness to continue cooperation in fixing the price of billets. The theory would predict AHB's retaliation in every market where Vizcaya was also present, following Vizcaya's exit from the cartel. However,

AHB accepted Vizcaya's proposal and both firms jointly set prices in the billets market. A similar situation occurred in May 1896: although collusion among AHB, Vizcaya and Asturian producers broke up, AHB and Vizcaya continued cooperation in the market for pig iron and rails.

3.3 Monitoring institutions

Collusion models assume that the mechanism that sustains above-equilibrium prices is the threat of retaliation if deviations from the collusive agreement are observed. In these models, it is up to the firms to detect deviations from specified market shares or prices, and hence to monitor the behavior of the rest of the firms included in the cartel. Monitoring effort may fall short of the optimal level if such effort is costly, which reduces the scope for collusion. Therefore, the presence of a party that is not a producer in the market where firms are colluding, but at the same time benefits from the very existence of the collusive agreement increases the likelihood of cartel survival. This is because of this player's incentive to monitor colluding firms' behavior to ensure the correct working of the cartel.

In this line, the distinctive feature of the cartel that was initiated in 1894 was the presence of the "Ibarra e Hijos" maritime company as a watching institution.⁹ The agreement initially included sales of iron to be used in the production of copper, although the agreement was extended to sales of iron, steel and rolled steel products in 1895. As opposed to the 1886 cartel, the foreign market was not included in the agreement, mostly because of the low interest of AHB in exporting.

In 1895 AHB, Vizcaya, and San Francisco, together with Ibarra e Hijos signed a five-year agreement with an automatic renewal clause. The treaty established the market shares for its member, fixed prices and granted Ibarra e Hijos the exclusive right to ship the goods produced by cartel members. Hence, Ibarra e Hijos had the ability to verify actual sales by cartel members, and also had the incentive to monitor firms' behavior. For instance, it had a strong incentive to verify that no iron was shipped by any other shipping company.

Additionally, Ibarra e Hijos acted as an intermediary in case of disagreement between firms. The fact that Ibarra e Hijos was not a producer or iron confers this firm with the independence required for efficient conflict solving, always seeking the continuation of the agreement. This is undoubtedly a factor that increases the likelihood of collusion being sustained. The continuing expansive cycle of the economy and the monopoly power of the syndicate formed by the three Spanish producers resulted in the highest price level for ingot in Europe. This success implied the extension of the collusive agreement until 1903, even after AHV was founded.

The 1886 agreement for sales of pig iron did not originally include a centralized sales agency, it was introduced only in April 1887, following a proposal

⁹References: Libro de Actas del C. de A. de AHB, tomo 6, 1893-95, p. 92, 27 de julio de 1894; pp. 98-101, 29 de agosto de 1894. Libro de Actas del C. de A. de la Vizcaya, tomo 4, 1892-95 pp. 290-292.

by Vizcaya. However, in this case, the existence of a common agent was not enough to keep the agreement alive. Indeed, as it was pointed out in the previous subsection, cartel members' interests were so divergent that the sales agent of the Syndicate resigned in October 1887. Later, the 1897 cartel, which included AHB, Vizcaya and some Asturian producers, also included a centralized sales agency, which also monitored firms' behavior.

3.4 Tariff protection and exchange rates

As pointed out in the previous section, tariff protection to the Spanish iron and steel industry increased in 1891 and in 1896. Simultaneously, other countries that would potentially become markets for Spanish products were also increasing tariff protection. These changes have two clear effects. On the one hand, higher tariff protection in the domestic market increases the scope for collusion and the incentives to collude in the domestic market. On the other hand, higher tariff protection abroad makes it more likely that domestic firms focus on the local market.

Changes in tariff protection had an important effect on Vizcaya's strategic turn in the 1890s. The firm's initial goal was to create a competitive producer of iron and steel, targeting the international market. However, in the 1890s, Vizcaya focused more intensively on the Spanish market. This shift was partially motivated by increased tariff protection in destination markets, but it is also clear that raising tariff protection in the Spanish market increases the opportunity cost of targeting foreign markets, since the domestic market becomes relatively more profitable. Hence, this increase in tariff protection increases the alignment of Vizcaya and AHB's interests. This may be seen by the longer duration of cartel agreements in the 1890s and the fact that AHB and Vizcaya continued cooperation in the sale of some products even after the collapse of collusive agreements with Asturian producers, for instance in 1891 and 1896.

It is also interesting to highlight AHB and Vizcaya's primer reaction to the passing of the 1891 Tariff Act. These two firms quickly started merger negotiations, although they ended up being unsuccessful because of discrepancies over the distribution of shares of the new company. However, this may be seen as a first attempt to become an industry leader in a highly protected market. The 1900-01 negotiations were successful, and AHV was created, as a result of the merger among AHB, Vizcaya and Iberia, a producer of finished steel products. The difference in economic environment between 1891 and 1900 was higher economic growth in 1900 and the existence of a high number of Spanish firms that produced finished iron and steel products. These firms had been created throughout the 1890s, under the protection of the 1891 Tariff, and were the natural outlet for AHB and Vizcaya's production. The existence of such customers in the industry rendered the merger more profitable, thus increasing the likelihood of success of the merger negotiations.

In addition to tariffs, exchange rates acted as a trade barrier throughout most of the 1890s. Figure 3 plots the exchange rate of the Spanish peseta to the British pound from March 1896 to December 1899. The gradual depreciation

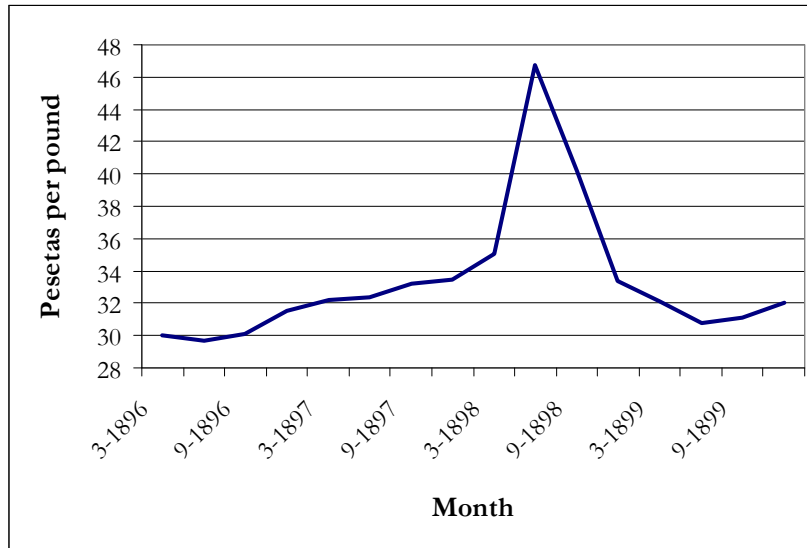


Figure 3: Spanish pesetas per British pound, 1896-99

of the Spanish peseta raised the maximum price that could be charged in the domestic market. Indeed, because of raising exchange rates, the firms included in the 1895 cartel agreed in 1897 on adjusting pig iron prices to the average price in Glasgow plus freight and tariff duties. The price was automatically adapted whenever the price of Scottish ingot showed a variation of more than 2 schillings. This is additional evidence on the satisfactory functioning of the cartel, and shows its ability to set prices above the equilibrium level. Indeed, cartel members had to reduce prices slightly in 1898 in order to avoid imports, since copper producers explored the possibility of importing iron from Britain because of prices that they considered to be outrageous. Prices of ingot were set to such a high level that made the production of other firms competitive and fostered their entry into the market. For example, Altos Hornos de Málaga started producing ingot in 1898.

4 Conclusions

Theoretical models of tacit collusion typically focus on firms' incentives to deviate and the design of punishment mechanisms to sustain above-equilibrium prices. However, in the historical case that we are analyzing, late 19th Century Spanish iron and steel industry, collusion was explicit, materialized in contracts that were indeed enforceable. This implies that models for tacit collusion may fail to consider interesting features of actual collusive agreements.

The study of collusive agreements signed by AHB and Vizcaya allows us to

highlight a number of factors that make collusion more or less sustainable. In line with previous research, falling demand increases the likelihood of collusion breakdown, whereas increasing demand, being by strong growth or by a raise in tariff protection increases the likelihood of collusion being sustained. In addition to demand, we have to take into account whether the cartel includes all the firms in the industry or leaves out a significant number of players. In the latter case, chances are that the cartel eventually breaks up, especially in the midst of a recession. However, the transition from cooperation to a price war is far from instantaneous, and is preceded by intense communication among cartel members.

The analysis of the Spanish iron and steel industry in the 19th Century also stresses the relevance of monitoring institutions in order to increase the likelihood of cartel survival. The 1894 cartel, where Ibarra e Hijos played the role of sales agent, shipper, and conflict solver, was a success story despite the fact that one of the members, San Francisco, had a different degree of vertical integration than AHB or Vizcaya, since San Francisco did not produce steel. The role of tariff protection in the creation and survival of cartels is also unquestionable. Price setting by cartels was the rule rather than the exception in the Spanish iron and steel industry after the passing of the 1891 Tariff Act.

This paper may serve as evidence suggesting future avenues of research for theoretical models of collusion. These models focus on a narrow set of features and may be enriched from considering other dimensions of cartel agreements, such as the ones presented in this paper. Hence, an attempt to fully explain the sustainability of collusion in a particular industry, based on theoretical models where the determinant of sustainability of collusion is, say fluctuations in demand may leave out crucial factors which might render such exercises as incomplete.

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