Battleships and Dividends: The Rise of Private Armaments Firms in Great Britain and Italy, c. 1860-1914

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Giulio Marchisio

This thesis analyses the rise of private armaments firms in Great Britain and in Italy from mid-19th century to the outbreak of the First World War, with a focus on naval armaments and military shipbuilding.

During this period, the armaments industry underwent a radical transformation, moving from being based on public-owned arsenals and yards to being based on private firms – the system of military procurement prevalent today. The key reason behind this transformation was the increasingly rapid evolution of military technology which started in the late 1850s and which was especially marked in naval ordnance and warship design. Guns and vessels, which previously could have been used for decades, were now outdated in a few years. Rapid technological change forced governments to constantly re-equip their armed forces, thus creating the opportunity for private firms both to supply goods which government arsenals did not make, and to supplement their production when this was not sufficient. It also favoured the expansion of the international armaments trade because advanced technologies were difficult to replicate. By 1914, private armaments firms had become the leading suppliers of crucial military hardware and the driving force behind technical innovations. Moreover, armaments firms now ranked among the largest private companies in many economies.

This research casts fresh light on this development through a comparative analysis of the Italian and British cases. Both countries experienced a similar trend, despite very different economic, strategic and political conditions. Analysing the evolution of their armaments industries thus highlights both the common long-term changes and the differences, notably in the relationship between private companies and governments, and the level of competition inside the industry.

Battleships and Dividends:

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Doctoral Thesis

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Quis fuit, horrendos primus qui protulit enses?

Quam ferus et vere ferreus ille fuit!

Tum caedes hominum generi, tum proelia nata,

Tum brevior dirae mortis aperta via est.

An nihil ille miser meruit, nos ad mala nostra

Vertimus, in saevas quod dedit ille feras?

(Tibullus, *Elegies*, I, 10, vv. 1 – 6)

Contents

List of Abbreviations

ACS	Archivio Centrale dello Stato, Roma
ADM	Admiralty
AFA	Archivio Fondazione Ansaldo, Genova
AST	Archivio di Stato di Terni
BL	Breech loading
col.	Column
DBI	*Dizionario Biografico degli Italiani*
f.	File
FP	Fondo Perrone [Perrone's records]
FT	Fondo Terni [Terni's records]
HCPP	House of Common, Parliamentary Papers
ML	Muzzle loading
MS(S).	Manuscript(S)
NA	National Archives, London
NDB	*Neue Deutsche Biographie*
ODNB	*Oxford Dictionary of National Biography* (Oxford, 2004)
p(p).	Page(s)
Pcm	Presidenza consiglio dei ministri [Office of the president of the council of ministers]
q(s).	Question(s)
QF	Quick-firing
rev.	Revised
SSB	Serie scatole blu [Blue boxes series]
SSMbis	Serie scatole marroni bis [Brown boxes series bis]
SSMter	Serie scatole marroni ter [Brown boxes series ter]
SSN	Serie scatole nere [Black boxes series]
SSR	Serie scatole rosse [Red boxes series]
T&W	Tyne & Wear Archive, Newcastle-upon-Tyne
VA	Vickers Archive, Cambridge University Library
vol.	Volume
WAS	Wirral Archives Service, Birkenhead
WO	War Office

Copyright

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Introduction

This thesis analyses the growth and evolution of the private armaments industry in Great Britain and Italy from the middle of the 19th century to the First World War. In these decades, the armaments business underwent a radical transformation: it moved from being predominantly based on publicly-owned arsenals and shipyards, to being dominated by a handful of large private firms.

From the 16th century until the mid-19th century, European governments steadily increased their role in the armaments sector: after asserting their legal monopoly of violence, governments became the dominant purchasers of heavy military hardware, and, at the same time, thanks to the network of plants and yards they owned, also the major producers of armaments. Until the 1850s artillery technology progressed at a slow pace. Technical obsolescence was a negligible problem: as William McNeill states: "[the] gun design developed … between 1465 and 1477 lasted until the 1840s with only marginal improvements."[1] Technological stagnation meant that warships and guns were kept in service for decades. In case of protracted warfare, private firms were sometimes integrated into the military procurement system to meet short-term peaks of demand. However, as soon as the need for additional military hardware ended, governments stopped buying from private suppliers and reverted exclusively on their arsenals and yard, whose output was sufficient to meet the demand of peacetime.

Starting in the 1860s, the armaments industry moved in a different direction, towards a situation in which private firms acquired a much larger role than before. What caused this transformation was the increasingly rapid evolution of military technology which, after centuries of slow, incremental, cumulative progress, entered into a phase of radical change. This evolution was especially evident in naval ordnance and warship design: guns and vessels which previously had been used for decades, if not centuries, now became obsolete in just a few years. Rapid technical change disrupted traditional procurement patterns in three ways. First, it created the opportunity for private firms, not just during military crises, but also in peacetime, to supply goods which government plants did not make. Governments had to constantly re-equip their armed forces with up-to-date hardware to keep pace with the evolution of military technology. Second, it favoured the expansion of the international armaments trade because many governments, especially the ones

[1] W. McNeill, *The Pursuit of Power. Technology, Armed Force, and Society since A.D. 1000* (Chicago, 1982), 88.

which did not own modern arsenals and plants, were eager to purchase the most sophisticated military hardware, given the high cost of not modernising their armed forces. This meant that firms capable of producing competitive military technology had now access to a much larger potential market than before. Third, by highlighting the growing role that technology and technical innovation played in modern warfare, it made governments more willing to interact with private firms able to develop and produce cutting-edge military goods. As a result, by 1914, in near all the advanced countries private armaments firms had grown into being leading suppliers of crucial military hardware (in some areas completely displacing government arsenals' production), and they had also become the driving force behind many new technical innovations.

The focus of the thesis is on the production of naval artillery and warships because it was exactly the demand for naval armaments which mainly stimulated the growth of private armaments firms before 1914. In the years 1850-1914, naval warfare was much more capital intensive than land warfare. For example, in the decade before the outbreak of the First World War, European navies spent on average between 35% and 55% of their budgets to purchase military hardware such as guns, warships and ammunitions; a value much higher than that of the land forces (5-12%).[2] In addition to this, there was also a qualitative difference: naval military hardware tended to be more sophisticated and expensive. As a consequence, private firms had an incentive to focus on satisfying the needs of navies rather than those of armies which still largely relied on government factories. For example, between 1909 and 1914, 80% of the British army's orders for guns and shells were placed with the Royal Ordnance Factories and 20% with the private industry; in the case of the Royal Navy the proportions were exactly the opposite.[3]

This work does not address the production of and trade in small and light weapons. Because of the very different commercial and technological conditions prevailing in the two markets, the production of small and large armaments systems was, and still is, undertaken by different companies. Thus, too little is shared by these two groups of firms to justify a common analysis.

Three main reasons justify this research. First, in the decades before 1914 the private armament industry became a significant part of the industrial sector in many European countries, with armaments firms ranking amongst the biggest national companies. For instance, in 1907 Armstrong and Vickers, the two major British armaments firms, were the second and third largest private employers in Great Britain, not counting railways companies. John Brown, another firm which was involved in warship-building and ordnance making, ranked seventh. All these firms

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2 D. Stevenson, *Armaments and the Coming of the War: Europe, 1904-1914* (Oxford, 1996), 10.
3 H. Strachan, *The First World War*, vol. 1, *To Arms* (Oxford, 2001), 1066.

employed more workers than the Royal Ordnance Factories. In Germany, Krupp was the single biggest private industrial employer.[4] In 1911 Ansaldo and Vickers-Terni – both deeply involved in armaments production – ranked second and seventh among Italian manufacturing companies, using a company's total assets rather than its number of workers as a yardstick.[5] In addition, armaments companies played a crucial role in terms of technological evolution, both through the activities of their own research departments, and by purchasing advanced technological goods from other companies – the big steel-made vessels produced before 1914 were the most sophisticated and complex technological products ever made up to that time.[6] Consequently it is important to study the evolution and the market organization of the armaments sector *per se*.

Second, the current procurement system, based on government contracts awarded to private firms, has its roots in the period covered by this thesis. As already stated, the shift from a public- to a private-based system of producing military hardware reversed the previous secular trend toward a greater role of governments in the broad sphere of "military and security". Since the sixteenth century, European governments (and also some non-European ones, such as the Japanese government during the Tokugawa Bakufu period) had struggled in order to assert their primacy in military affairs. One of the most effective way governments used was to gain a quasi-monopoly in the manufacturing of the most important "tools of violence", such as guns and warships.[7] The central position enjoyed by government-owned establishments started to be eroded in the last decades of the nineteenth century by a growing private armaments industry. Therefore, such a crucial turning point deserves to be fully investigated.

Third, despite its peculiarities, the armaments industry is characterised by features (e.g. high entrance barriers, substantial learning costs for new entrants, the need for huge capital investments, etc.) which can also be found in other industrial sectors, such as the petroleum and heavy chemical

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4 P. Wardley, 'The Emergence of Big Business: The Largest Corporate Employers of Labour in the United Kingdom, Germany and the United States, c. 1907' *Business History* 41 (1999), 102 and 108.

5 IMITA.db, Archivio Storico delle Società per Azioni Italiane, http://imitadb.unisi.it/index.asp (accessed 15 August 2012).

6 C. Trebilcock, '"Spin-Off" in British Economic History: Armaments and Industry, 1760-1914' *Economic History Review* 22 (1969), 474-490; id., 'British Armaments and European Industrialization, 1890-1914' *Economic History Review* 26 (1973), 254-272.

7 The literature on this topic is enormous. See for reference: G. Parker, *The Military Revolution: Military Innovation and the Rise of the West, 1500-1800* (Cambridge, 1988); J. Black, *A Military Revolution? Military Change and European Society, 1550–1800* (London, 1991); C. Rogers, *The Military Revolution Debate* (Oxford, 1995); P. Del Negro, *Guerra ed Eserciti da Macchiavelli a Napoleone* (Roma-Bari, 2001), 3-121. J. Glete, *Warships, Navies and State Building in Europe and America, 1500-1860* (Stockholm, 1993) offers an overview which stresses the role played by battle fleets, and their construction cost, in state building. The case of the Tokugawa Japan is very instructive: in 1615, at the end of a bloody civil war which saw extensive use of fire arms, the Tokugawa family gained political supremacy in the country. The new government was able to exercise such an unchallenged monopoly of violence that it reduced, and then virtually eliminated, the use and production of fire arms in the country, see N. Perrin, *Giving Up the Gun* (Boston, 1979), and D. L. Howell, 'The Social Life of Firearms in Tokugawa Japan', *Japanese Studies* 29 (2009), 65-80.

industries. This research, thus, by contributing to a better understanding of the dynamics and trends shaping the armaments industry, has the potentiality to also benefit research in adjacent areas.

Whereas the current military procurement system has its roots in the decades covered by this thesis, there is a significant difference between the pre-1914 and the post-First World War periods which needs to be mentioned. Starting from the Great War, armaments production and trade became highly regulated activities. National laws and international treaties have been introduced by governments with the aim of controlling this strategic sector. In contrast, before 1914 governments tolerated free trade of armaments and also free flows of information and technical expertise while participating in naval arms race. Even Great Britain, which, as the major naval power before 1914 might have had an interest in limiting the sale of naval armaments and warships, did not regulate these activities. As the report of the Royal Commission on the Private Manufacture of and Trading in Arms appointed in 1935 reported, before the Great War the only legal provision specifically devoted to regulating the armaments trade was the Exportation of Arms Act 1900 which gave the power to the government "to prohibit the exportation ... of arms, ammunition, military and naval stores ... to prevent [them] be used against Her Majesty's subjects and forces."[8] However, before 1914 British governments do not appear to have exercised this power.

The main reason why before 1914 governments generally adopted this light-touch attitude was the nature of naval warfare. Until the First World War, governments expected to fight relatively short wars. Hence, what mattered was the size of a navy at the beginning of the hostilities: a conflict was expected to terminate before large numbers of warships could be built to reinforce the warring fleets. Therefore Great Britain had nothing to fear so long as the Royal Navy maintained its large numerical supremacy over the fleets of the other powers. Moreover, if a conflict was to last more than just a few months, having a well developed private armaments industry – which could thrive exactly because it had the possibility to sell abroad when internal demand was stagnant – might be a crucial asset: the capacity of private companies could be added to that of the government-owned arsenals to rapidly escalate production. This idea of the private armaments industry as a potential strategic asset which governments could tap in case of conflict was often propagated by armaments firms themselves: for example, the editorials published by the British trade journal *Arms and Explosives* routinely stressed that only if British firms were left free to sell their wares abroad, and thus maintain their production facilities up-to-date and competitive thanks to these profitable exports, could they play a valuable role in case of conflict. For every warship or gun sold abroad,

[8] HCPP, *Royal Commission on the Private Manufacture of and Trading in Arms (1935-36). Report*, p. 69.

the British government could easily order twice as many to its own arsenals and to the private industry.

The same line of reasoning justified the governments' lack of strict control over the flow of technical information. Given the state of military technology before 1914, it was hardly possible for a company to maintain a consistent technological lead for many years. For instance, in the case of armour plates the various improvements which were developed in the course of the 1890s were basically the result of a "trial-and-error" approach. Under these circumstances, as will be explained in more detail in chapter VI, it was rationale for firms to purchase the rights to use foreign-developed patents, rather than embark on autonomous investigations, and for governments to allow this to happen, in order to obtain rapid access to any technical advance. As a consequence, no navy made the quest for technological superiority the linchpin of its strategy (with the partial brief exception of the French *Jeune École*). Numerical advantage, better tactical leadership and superior organisation were generally regarded as the crucial factors which would have decided a clash between fleets made up of broadly similar vessels.

In addition to this "strategic" rationale, other more mundane reasons justified the light-touch policy adopted by governments. Armaments sales could cement political and economic links between countries. The Italian government, for instance, supported Ansaldo's efforts to sell warships to Southern American republics because it thought it was a way to enhance Italy's role there. Moreover, sales of armaments played a positive role in the balance of payments of a country, a central preoccupation for governments under the gold standard system. Finally, as will be more fully explained in the following section on historiography, it was only after the First World War that the armaments industry started to be generally regarded as an activity which, for its nature, needed to be more carefully supervised and monitored.

This research adopts a comparative approach, analysing the British and Italian experiences. The rationale for this comparison is twofold.

The first reasons is that, during the entire period covered by this thesis, the links connecting the Italian and British armaments industries were numerous and deep, more so than that among the armaments industries of other countries (only the association between British firms and Japan was similar for magnitude, but it spanned a much shorter period of time). From the establishment of Armstrong, the Italian government was among its most important and loyal customers, and it kept patronising the firm and it the 1880s it was able to convince the British company to create a plant in Italy, at Pozzuoli – the single largest and longest foreign direct investment ever undertook by a European armaments firm before 1914. In addition to this, in 1903 Armstrong acquired a large stake

in the capital of Ansaldo, the major Italian armaments firm, even though it sold its shares after a few years. During the early 1900s Vickers, the other major British military company, also entered the Italian market. It signed an agreement with Terni, a steel and engineering conglomerate which owned the second largest private yards for warship construction in the country, to establish a new artillery making plant in Italy. These intense and protracted connections thus justify a side-by-side analysis.

The second reason is that a comparative approach has the potentiality to result in a more complete and nuanced reconstruction of the activities of the Italian and British armaments industries both by emphasising the common features and by contrasting the differences, between the Italian and British experiences. The armaments industry in both countries went through a similar general trend favouring the growth of private firms. As a result, at the beginning of the First World War private armaments companies were well established in both Britain and Italy, and after some initial difficulties they proved able to supply their governments with a constant stream of military hardware. This development happened notwithstanding the very different economic, political and social conditions prevailing in the two countries – Great Britain being the leading power in the world whereas Italy "the least of the great powers", as it has been called by Richard Bosworth[9]. At the same time, Italian and British armaments industries differed in some crucial aspects. For instance, British firms were more prone to collaborate among themselves than were those in Italy; the relationship between firms and governments was also distinct, with the Italian government being much more active in promoting industrial ventures than the British one. The impact and significance of these specific features can only be assessed if compared with a different case. Finally, this thesis will also fill a gap in the literature. There are few comparative studies of the evolution of the armaments sector in Europe before 1914, and none with an Anglo-Italian perspective.[10]

Space and gaps in the sources do not allow a complete reconstruction of the performance of every company operating in this field, or consideration of every technological innovation. The focus of the thesis is, on the contrary, on the overall development of the armaments industries in the two countries, the relative positions of the various manufactures, their strategies and the impact that technological innovation had on governments' policies and on private actors. This approach has the potential to better emphasize the long-term changes which occurred in the period 1860-1914.

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9 R. Bosworth, *Italy, the Least of the Great Powers: Italian Foreign Policy Before the First World War* (Cambridge, 1979).

10 Anderson, *Armaments*, 18-40; and L. Segreto, 'Parter e Rivali nell'Industria degli Armamanti', P. Hertner (ed.), *Storia dell'Ansaldo.* Vol. 3, *Dai Bombrini ai Perrone, 1903-1914* (Roma-Bari, 1996), 111-115, offer surveys of the European armaments industry in the decade before the First World War. Both overviews, however, are exclusively based on few secondary sources and are not intended to offer a comparative analysis of the evolution of armaments firms in different countries.

Historiography

The first works dealing with private armaments companies appeared in Britain in the decade before the First World War.[11] The huge and growing amount of money which the governments of the major powers of the time were devoting to military spending could not go unnoticed. Especially after the introduction of the new dreadnought battleships in the early 1900s, scholars, journalists, intellectuals and political activists started to wrote extensively about armaments spending. Various naval arms race, of which the most famous was the one between Germany and Great Britain, stimulated further interest in the topic.

The publications which appeared in this period can be divided in two groups. Works belonging to the first group questioned the value of governments' spending on armaments; those in the second group concentrated on criticising the activities and operations of private armaments companies. Works in the first group often focused on the absolute level of military spending.[12] Tracing their intellectual origins to Richard Cobden, their authors advanced what might be called "the economic argument against military spending".[13] For them military spending was inherently wasteful; free trade and commerce were the most effective means to enhance international security, while armaments spending generated uncertainty by causing costly armaments races, and, especially, diverted precious resources which could be used to achieve other, more useful, goals, or simply returned to the citizens as lower taxes. While there was no doubt that armaments firms were handsomely profiteering from the opportunities generated by defence spending, the key issue for these authors was governments' decision to spend taxpayers' money on armaments. The fundamental problem was therefore political, one of priorities. This criticism, however, could be more easily applied to expenditures for armies than for navies: the latter, in fact, were the key instrument used to maintain sea lanes open and safe, therefore helping trade and prosperity.[14]

The second group of works, which started to appear in the last few years before 1914,[15] firmly concentrated on the activities of private armaments firms.[16] The authors of these works

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[11] The aim of this literature review is that of assessing the most significant works offering an analysis of the activities of private armaments firms. Mapping the development of anti-armaments ideas goes beyond its scope.

[12] Among the many: Cobden Club, *The Burden of Armaments: A Plea for Retrenchment* (London, 1905), and G. H. Perris, *For an Arrest of Armaments. A Note for the Second Hague Conference* (London, 1906).

[13] R. Cobden, *The Political Writings of Richard Cobden*, 2 volumes (London, 1903), *passim*; E. P. Stringham, 'Commerce, Markets, and Peace. Richard Cobden Enduring Lessons', *The Independent Review* 9 (2004), 105-116.

[14] G. Jordan, 'Pensions not Dreadnoughts: the Radicals and Naval Retrenchment', A. J. A. Morris (ed.), *Edwardian Radicalism, 1900-14* (London, 1974), 162-179.

[15] C. Trebilcock, 'Radicalism and the Armament Trust', Morris (ed.), *Radicalism*, 181.

[16] For instance, G. H. Perris, *The War Traders* (London, 1913), P. Snowden, *Dreadnoughts and Dividends: Exposure of the Armaments Ring* (Boston, 1914), H. R. Murray, *Krupp and the International Armament Ring* (London, 1915),

arrived at the same conclusions as the authors of the first group, that is, that armaments spending was a waste of taxpayers' money. The difference was they stressed the role played by private armaments firms: they argued that private companies were shaping government policies to their own advantages. Thanks to exchanges of favours, political and financial support, and outright bribery a small, close-knit group of greedy armaments entrepreneurs had gained a decisive influence upon government spending. Competition between armaments firms was only apparent: companies actually belonged to international cartels and trusts designated to fix prices and divide markets. Rivalries and disputes between countries were exploited, if not artfully created by the same armaments companies, to stimulate sales. The result was a thriving business for the armaments companies, but a heavy burden for the public, and a growing level of international tensions.

Also in Italy the amount of resources absorbed by defence spending generated controversies, although the fact that military affairs firmly belonged to the sphere of influence of the king limited the scope for open criticism. The most relevant contributions came from liberal and free trade economists such as Edoardo Giretti, Antonio de Viti de Marco, Vilfredo Pareto and Luigi Einaudi, who from the pages of the *Giornale degli Economisti* or the *Corriere della Sera* denounced the special relationship which existed between the government, on one side, and a handful of private firms involved in armaments production, on the other. They accused private firms to unlawfully profit from government contracts by inflating costs, and the government to be unable to properly supervise how such a large part of its budget was spent.[17] In general, a problem which all the authors writing on the armaments industry period faced in this was the limited amount of information they could rely on. Data on government spending were usually available, although with varying degrees of completeness; but private companies disclosed little financial information apart from final years' results. On the contrary, technical details circulated quite freely on newspapers and trade journals.

At the end of the First World War, and for the next two decades, armaments remained an important topic of public discourse. This occurred for two reasons. The first reason was that excessive armaments spending was regarded as one of the crucial causes of the First World War, if not the major one. As the former British Foreign Secretary Sir Edward Grey wrote: “The enormous growth of armaments in Europe, the sense of insecurity and fear caused by them – it was these that made war inevitable.”[18] Hence, it is not surprising that the fourth of President Wilson's fourteen

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J. T. W. Newbold, *The Armament Trust Exposed* (London, 1916).

17 For example, E. Giretti, ‘La Società Terni, il Governo e il “Trust” Metallurgico’, *Giornale degli Economisti* 12 (1903), 309-364, and L. Einaudi, ‘L’Odierna Crisi di Borsa ed i suoi Insegnamenti’, *Corriere della Sera* 20 November 1906, 1.

18 E. Gray, *Twenty-Five Years, 1892-1916* (London, 1925), vol. 1, 90.

points dealt with armaments: “Adequate guarantees given and taken that national armaments will be reduced to the lowest points consistent with domestic safety.”[19] The Covenant of the League of Nations explicitly endorsed this view stating that: “The Members of the League recognise that the maintenance of peace requires the reduction of national armaments to the lowest point consistent with national safety."[20] As a consequence, during the 1920s and 1930s various political meetings – the Washington Naval Conference in 1922, the Paris conference resulting in Kellogg-Briand Pact in 1928 and the World Disarmament Conferences in 1932-34 – were organised with the aim of limiting armaments spending.

The second reason was the occurrence of polemic on “war profiteering” in more or less all the major belligerent countries after the conclusion of the conflict. In wartime armaments companies (and other private suppliers) had obtained large profits on the unprecedented amount of orders they had received from governments.[21] These war profits generated much controversy both during the conflict and, especially, after it.[22] For example, special parliamentary committees were created in Italy (Commissione d'Inchiesta Parlamentare sulle Spese di Guerra, 1920-1923), in the United States (Special Committee on Investigation of the Munitions Industry, or Nye's Committee from the name of its chairman, Senator Gerald Nye, 1934-1936) and in Great Britain (Royal Commission on the Private Manufacture of and Trading in Arms, 1935-1936) to investigate war profits, how government contracts had been handled during the conflict, and also what practical limits could be imposed on armaments trade and production.[23] These committees collected vast amount of documents and testimonies which, even though they mainly focus on the war period, also offer useful information about the pre-war years – the records of the British Royal Commission have been especially valuable for this research.

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[19] The text of Wilson's fourteen points is available on the website of the Avalon Project of the Yale University, http://avalon.law.yale.edu/20th_century/wilson14.asp.

[20] The text of the Covenant is equally available online: http://avalon.law.yale.edu/20th_century/leagcov.asp. On the impact of this article on the League's activities: Z. Steiner, *The Lights that Failed. European International History 1919-1933* (Oxford, 2005), 372-73.

[21] For an analysis of how accounting practises impacted on war profits: A. Loft, ‘Accountancy and the First World War’, A. G. Hopwood and P. Miller (eds.), *Accounting as Social and Institutional Practice* (Cambridge, 1994), 116-137.

[22] J. S. Boswell and B. R. Johns, ‘Patriots or Profiteers? British Businessmen and the First World War’, *Journal of European Economic History* 11 (1982), 423-446; and also E. A. Molander, ‘Historical Antecedents of Military-Industrial Criticism’, *Military Affairs* 40 (1976), 59-63.

[23] The final report of the Italian committee and all the materials it assembled have been recently republished: C. Crocella and F. Mazzonis (eds.), *L'Inchiesta Parlamentare sulle Spese di Guerra (1920-1923)*, 3 volumes (Roma, 2002). On the Nye Committee: J. E. Wiltz, *In Search of Peace: The Senate Munitions Enquiry, 1934-1936* (Baton Rouge, 1963). On the British Royal Commission: D. G. Anderson, ‘British Rearmament and the “Merchants of Deaths”: The 1935-36 Royal Commission on the Manufacture and Trade in Armaments’, *Journal of Contemporary History* 29 (1994), 5-37; on the British government attitudes towards this problem, N. Rollings, ‘Whiteall and the Control of Prices and Profits in a Major War, 1919-1939’, *The Historical Journal* 44 (2001), 517-540.

The experience of the First World War stimulated a new series of publications restating the criticisms which had already been levelled against armaments firms before 1914.[24] The most influential work was *Merchants of Death* published in 1934 in the United States by Engelbrecht and Hanighen. The book's arguments were the same as those which had been advanced twenty years before: armaments firms exercised a powerful influence in public life, and used it to enrich their managers and shareholders. Fomenting war scares, paying journalists to excite jingoistic feelings, selling armaments to countries fighting each other, offering money and well-paid post-service employments to influential officers, bribing politicians and bureaucrats – all these were means which private armaments firms allegedly used to increase their profits.[25]

Two things, however, differentiated *Merchants of Death* from earlier works. First of all, its length: the first edition of Engelbrecht and Hanighen's book run for more than 250 pages, a significant difference from the works which appeared before 1914, which in the majority were pamphlets longer no more than few tens of pages. Second, the length of the book allowed the authors to offer a more systematic and articulated analysis of the history of the armaments industry. While the pre-war literature was mainly focused on contemporary and specific events, *Merchants of Death* covered more than a century of history (opening with the story of Irénée Du Pont setting up a gun powder mill in the United States at the beginning of the 19th century), spanning the entire world, from Europe to South America to Japan. The breadth and scope of the volume, which was enriched with photographs and diagrams, do not cover the fact, however, that it also suffered from the fact that the authors did not enjoy access to business archives and hence relied mainly on previously published anti-armaments materials and newspapers articles. The impact the book had can be gauged, however, from the success enjoyed by the expression "merchants of death" ever since.[26]

Another book written in the inter-war period was Eckart Kehr's *Battleship Building and Party Politics in Germany, 1894-1901*.[27] Kehr examined how different social groups and vested interests interacted inside and outside the Reichstag to build up the momentum for the approval of laws financing German naval rearmament. The book, which does not focus on the internal

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[24] The most relevant books published in this period were: A. F. Brockway, *The Bloody Traffic* (London, 1933), P. Noel-Baker, *The Private Manufacture of Armaments* (London, 1936), and H. C. Engelbrecht and F. C. Hanighen, *Merchants of Death. A Study of the International Armament Industry* (New York, 1934).

[25] T. H. Tooley, 'Merchants of Death revisited', *Journal of Libertarian Studies* 19 (2005), 37-78, offers a stimulating evaluation of the book.

[26] Using Google Ngram Viewer (http://books.google.com/ngrams) to investigate the corpus of digitalised books in Google Books it is possible to verify that the collocation "merchants of death" had virtually no occurrences before 1934, while there was a marked increase in its use in the second part of that decade.

[27] E. Kehr, *Battleship Building and Party Politics in Germany, 1894-1901. A Cross-Section of the Political, Social, and Ideological Preconditions of German Imperialism* (Chicago and London, 1973), originally published in 1930.

operations of armaments firms, but on a broader political perspective, relied on a much larger body of primary sources. Kehr's major contribution was to stress the importance of internal political and economic factors in shaping the defence policy of the German state, in contrast to the scholars who saw the external and diplomatic events as the crucial factors behind armaments spending. Kehr's work went unnoticed during his lifetime (he died in 1933), however, and was rediscovered only in the 1960s, in the context of a new wave of academic interest for armaments industry.[28]

At the end of the Second World War, unlike after the First, armaments companies did not rank high on the academic research agenda because they were not regarded as having played a role in the outbreak of the conflict. As a result, for more than a decade, no significant study about the armaments industry was published.

During the second half of the 1950s economic and political events again raised interest in the armaments business. With the outbreak of the Korean War in 1951, the defence spending of the United States, the Soviet Union and several European countries started to expand. A major reason which was advanced to explain the growth of military spending in peacetime was the influence of what President Eisenhower labelled in his farewell address in 1961 "the military-industrial complex", that is, the notion that there exists a web of relationships involving government bureaucracies, armed forces and industrial producers aiming to gain approval for programmes financing the production and maintenance of unnecessary military hardware – programmes which end with huge profits for the private companies, a growing role for the military bureaucracies, and a larger place for the government inside the economy.[29] The result is a combination of interests and influences which could threaten democracy. It is immediately clear that the concept of military-industrial complex owns a lot to the "merchants of death" theory. The major difference is that proponents of the military-industrial complex regard the political, military and industrial groups as a single, unified body, rather than as separate groups. The military-industrial complex proved to be a very popular concept.[30] Hundreds of books and articles about this topic have been published since the 1960s,[31] the majority about the experience of the United States after the Second World War, a

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[28] On the academic impact of Kehr' works, see A. Wehler, 'Kehr, Eckart', L. Boia (ed.), *Great Historians of the Modern Age: An International Dictionary* (New York, 1991).

[29] S. Melman, *Pentagon Capitalism: the Political Economy of War* (New York, 1970) is a good analysis of the impact that military spending had on the American economy.

[30] The popularity of the expression "military-industrial complex" can be gauged once again using Google Ngram Viewer. It started to be used in 1961 and it had enjoyed a growing popularity ever since, with pecks in the early 1970s, late 1980s and late 1990s.

[31] Using Worldcat (a website indexing the catalogues of around 72,000 libraries around the world) for volumes with the words "military-industrial complex" in the title returns 760 entries. Among the most relevant publications are: S. Rosen, *Testing the Theory of the Military-Industrial Complex* (Lexington, 1973); S. Lens, *The Military-Industrial Complex* (Philadelphia, 1980); P. A. Koistinen, *The Military-industrial Complex: A Historical Perspective* (New York, 1980); R. T. Robin, *The Making of the Cold War Enemy: Culture and Politics in the Military-Industrial Complex* (Princeton, 2003); S. T. Brandes, *Warhogs. A History of War Profits in America* (Lexington, 1997); S.

natural consequence of the fact that the American military budget has been the largest in the world since the 1940s.[32]

Armaments was a popular research topic for scholars of different disciplines, among them sociologists and economists. For instance, the sociologist C. Wright Mills had anticipated some features of the military-industrial complex in his book *Power Elite* on the structures of power inside the United States. He pointed to the special relationships and interconnected interests which existed between military, political and business groups. He saw these three groups at the head of hierarchical structures (the army, the government, the large corporations) characterising the activities of the modern centralised bureaucratic state. These groups, according to Wright Mills, were able to shape governmental policies to their own benefit because of their unity of purpose, whereas mass society, fragmented and divided, was impotent to reverse their actions. Large defence appropriations were then used by the dominant elite to reinforce their position.[33]

Armaments manufacturing equally had a significant role in the analysis of the modern capitalist economy proposed by the prominent Marxist economists Paul Sweezy and Paul Baran.[34] According to them, the economic surplus produced inside the capitalistic economy was only partially absorbed by consumer spending. The remaining share was used by the government to finance military spending which was used to keep industrial capacity employed. In Sweezy and Baran's model, therefore, the armaments industry plays the central role in the continued functioning of a capitalist economy.

These works, though, focus primarily on general trends and offer theoretical insights, rather than empirical analysis. Although they show that there are (and were) links between private companies and public bureaucrats, they do not clarify the direction of causality. Do private entrepreneurs dictate the government policies, or do public bureaucracies enjoy the upper hand? Whatever their findings these works had the merit of considering the armaments industry in terms of its relevance in the economy, rather than just in moralistic terms.

Both the "merchants of death" hypothesis and the "military-industrial complex", however, are inadequate to provide an historical interpretation of the rise and evolution of private armaments

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Lieberson, 'An Empirical Study of the Military-Industrial linkages', *American Journal of Sociology* 76 (1971), 562-584; B. Baack and E. Ray, 'The Political Economy of the Origins of the Military-Industrial Complex in the USA', *Journal of Economic History* 45 (1985), 369-375; W. Adams and W. J. Adams, 'The Military-Industrial Complex: a Market Structure Analysis', *American Economic Review* 62 (1972), 279-287; B. F. Cooling, *Grey Steel and Blue Water Navy: The Formative Years of America's Military-Industrial Complex, 1881-1917* (Hamden, 1979); S. C. Sarkesian (ed.), *The Military-Industrial Complex: A reassessment* (Beverly Hills, 1972).

[32] The fact that *Enterprise & Society* devoted a special issue, published in March 2011, to a reappraisal of the American military-industrial complex is a further testimony of the continuous popularity of the topic.

[33] C. Wright Mills, *The Power Elite* (New York, 1956).

[34] P. Sweezy and P. Baran, *Monopoly Capital: An Essay on the American Economic and Social Order* (London, 1968).

firms before 1914. First of all, they cannot explain why a private armament industry started to grow in the mid-19th century. Second, they cannot account for the varied performance of armaments firms: if all of them adopt the same strategy, why were some more successful than others? Third, they do not give enough consideration to the differences which existed between the armaments industries in different countries.

Another scholar who contributed important insights on armaments was Alexander Gerschenkron. Gerschenkron never actually interested himself in the armaments industry, or in the dynamic of military spending. His major contribution was to offer a model of economic development which stressed the importance of the state's activities. He focused on the economic performance of the European countries, such as Italy, Germany and Russia, whose industrial development he claimed occurred in the last decades of the 19th century.[35] Gerschenkron advanced the idea that in these countries governments and the universal, German-style banks played a crucial role as agents of development.[36] According to his analysis, second comer countries suffered from the absence of several of the prerequisites of economic development which Britain or France enjoyed during their industrialisation: management capacity, planning and business skills were especially in short supply. To overcome these problems, governments and banks coordinated and supported industrial sectors and individual firms to achieve industrial growth. Tariffs, public spending, mergers, interlocking directorates, were all means used to promote economic development and catch up with the most advanced economies. The importance of Gerschenkron's model was that it opened a new perspective on the role and importance of military spending. The purchase of military hardware rather than being unproductive and wasteful, provided a significant contribution to the economic take off of second-comer countries by stimulating industrial development and technological advanced productions.

During the 1960s Clive Trebilcock published the first of his many contributions on the history of the British and European armaments industries before 1914.[37] Trebilcock's works exercised a profound and lasting influence on subsequent scholars approaching the same topic. Three major novelties characterised Trebilcock's work: first, he reassessed the relationship between governments and private armaments firms; second he looked at armaments companies first and foremost as business ventures; third, he advanced a model of the industrialisation of second-comer

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[35] Gerschenkron based his views on the economic statistics he had at his disposal or which he produced. New historical series on the Italian industrial sector, for instance, cast doubts on the real magnitude of the "great spur" which, according to Gerschenkron, characterised the Italian economy in the last years of the 19th century: see S. Fenoaltea, *L'Economia Italiana dall'Unità alla Grande Guerra* (Roma-Bari, 2005), 11-76.

[36] A. Gerschenkron, *Economic Backwardness in Historical Perspective: a Book of Essays* (Cambridge, Mass, 1962).

[37] C. Trebilcock, 'A "Special Relationship". Government Rearmament and the Cordite Firms', *Economic History Review* 19 (1966), 364-379.

European states in which armaments firms played a major role.

According to Trebilcock, the idea of governments being manipulated by private armaments firms is wrong. On the contrary, Trebilcock offered historical evidence of the significant leverage which governments enjoyed upon private companies. Firms manufacturing armaments totally depended on governments' defence expenditure, whose level they had little power to influence. Orders followed an erratic pace, with periods of burgeoning sales followed by phases of depression. Moreover, governments played manufacturers against each other to gain better prices and conditions, and their chief preoccupation was always keeping government-owned factories busy. In addition, spending decisions could take years to materialise, while firms had to invest large sums to maintain their plants up to date to satisfy the military bureaucracies' never-ending demands for new and improved technical features. The armaments market was oligopolistic both on the demand (the number of purchasers was limited) and on the supply side (there were few firms able to produce the largest and more complex armaments), and it was characterised by very high levels of information asymmetry: armaments firms could not easily forecast future armaments trends, but governments equally had limited means to verify the congruence of the prices paid for armaments. Clearly, all these facts did not prevent private firms from obtaining large profits, but Trebilcock convincingly dismissed the idea that governments were puppets in the hand of armaments firms.[38] Indeed, the mutual interdependence of the government demand for armaments, and private companies' reliance on government spending, made their relationship much more complex and nuanced.

Trebilcock equally stressed the fact that the arms manufacturers were first and foremost entrepreneurs. Consequently, their behaviour can best be understood as essentially based on profit-seeking entrepreneurial logic and on the existence of an autonomous sphere of business decision making. Armaments firms, like all companies, responded to market incentives. Therefore it becomes crucial to understand the dynamic of their internal operations, their strategies, rather than to investigate the links between the armaments industry and the government (a relationship which, as already stated, was more complex than previously thought). Thus historians have to approach the study of the armaments companies using the standard tools of business history and economics, focusing especially on the accounting records and other internal documents. In the 1970s this had become possible because business records for the pre-1914 period started to become available to researchers. Trebilcock himself employed these techniques in writing his book on the history of Vickers.[39] In *The Vickers Brothers* he focused on the internal decision making process of the firm,

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[38] Id., 'Legends of the British Armament Industry 1890-1914: A Revision', *Journal of Contemporary History* 5 (1970), 3-19.

[39] Id., *The Vickers Brothers. Armaments and Enterprise 1854-1914* (London, 1977).

stressing the management's capacity to foster technical innovation, control the operations of an expanding firm and rapidly adapt the firm's strategy to the external environment. For the first time, an armaments firm was studied "from inside".

The third idea that Trebilcock advanced was that the armaments sector had played a positive role in the industrialisation process. Trebilcock claimed that the positive impact that armaments had on the economy was not so much quantitative (additional demands for semi-finished goods or raw materials) but qualitative, through a process of technological transfer between civil and military sectors – a process tracing its roots at least to the 18th century, although it mainly displayed its effects in the last decades of the 19th century. Trebilcock concluded that armaments companies played a crucial and positive role in the British economy: "the energy and efficiency of the arms firms were not restrained in an industrial enclave but, rather, were partly "spun-off" into general industry."[40] Trebilcock, however, considered the role of armaments companies still more relevant in the second comer countries of continental Europe, praising the contribution that the private armaments companies made to industrial growth.[41] He claimed that in countries such as Italy, Russia and Spain, the armaments industry played the same role that railway construction had in Britain, stimulating economic growth and technological development. Trebilcock's assessment was influenced by the Apollo Programme and other contemporary military-oriented industrial programmes which were playing a crucial role in the development of new far-reaching technologies which also started to be employed in non-military sectors. Although Trebilcock's findings can be criticised (for example, his assessment of the role of armaments industries in the development of second comer countries seems too positive),[42] his business-based, nuanced and non moralistic approach to the subject has had a lasting influence in stimulating studies on the same topic both in Great Britain and abroad.

Trebilcock's work and the opening of various business archives stimulated a new wave of interest in the history of individual armaments companies and of the armaments industry in general. Subsequent works can be divided into two groups: the first group, which can be labelled "political economy analysis", is composed of works which return to investigating the nexus of armaments,

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40 C. Trebilcock, '"Spin-Off" in British Economic History: Armament and Industry, 1760-1914', *Economic History Review* 22 (1969), 490; and id., '"Spin-Off" and the Armaments Industry: Rejoinder', *Economic History Review* 24 (1971), 464-468.

41 C. Trebilcock, 'British Armaments and European Industrializations 1890-1914', *Economic History Review* 26 (1973), 254-272; and id., 'British Armaments and European Industrialization, 1890-1914: The Spanish Case Re-Affirmed', *Economic History Review* 27 (1974), 625-631; and id., *The Industrialisation of the Continental Powers, 1780-1914* (London, 1981).

42 For example, Giovanni Federico and Jon Cohen reviewing the literature on the Italian economic history downplay the role of large firms in the development of the country in the years before the First World War, G. Federico and J. Cohen, *The Growth of the Italian Economy, 1820-1960* (Cambridge, 2001), 46-47 and 67-68.

governments and military elite. Despite the limited heuristic value of the concept of "military-industrial complex", historians of modern European history could not ignore the role played by the armament industry inside many European countries in the decades before 1914. Among these works, *Germany and the Approach of War in 1914* by Volker Berghahn should be highlighted.[43] Berghahn claimed that Germany pursed its ambitious naval plan despite the government struggled to finance it, and the fact that Great Britain maintained a decisive lead in naval construction, because of a "path dependency" effect. Too many economic and political interests had come to depend on the naval programme; consequently, notwithstanding its costs and lack of success, it was not stopped. Although this hypothesis is convincing, Berghahn focused largely on political sources. The business side of the problem received only scant attention and the book lacked references to business records.

Another important work in this group is Peter Gatrell's *Government, Industry and Rearmament in Russia, 1900-1914.*[44] Gatrell assessed the links between the Russian government and the country's armaments industry in the decade before 1914. According to Gatrell, Russia failed to develop an effective working relationship with private armaments firms, despite the rearmament policy implemented after the ruinous war with Japan which had forced the government to rely more on the private sector. Deep-rooted defects in the economic and political life of the country led to confusion and incoherent policies which resulted in a dramatic shortage of rifles, shells, artillery and other military hardware during the First World War. One of the major limitations was the deep suspicion which many bureaucrats and official harboured towards private enterprises and their activities – something which obviously damaged their operations. Gatrell thus presented a picture of a complex and confrontational relationship between the Tsarist government and the private armaments industry, one in which collusion and cooperation was mixed with suspicion and diffidence.

The Italian cases has been analysed in the works produced by two scholars: Luciano Segreto and Paolo Ferrari. Luciano Segreto published his volume *Marte e Mercurio* in 1997.[45] The book is a collection of several previously published essays on the Italian economy after 1914, to which a new introductory chapter was added. It is in this new chapter that Segreto offers a general overview of the Italian armaments industry and its relation with the government. He highlights the specific

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[43] V. G. Berghahn, *Germany and the Approach of War in 1914* (London, 1973). Other books dealing with the role of the armaments programmes in Imperial Germany are J. Steinberg, *Yesterday's Deterrent. Tirpitz and the Birth of the German Battle Fleet* (New York, 1965) which focuses on the parliamentary approval of the First Navy Law in 1898; H. Wehler, *The German Empire, 1871-1918* (Leamington Spa, 1985), 146-170, offers a more general overview.

[44] P. Gatrell, *Government, Industry and Rearmament in Russia, 1900-1914. The Last Argument of Tsarism* (Cambridge, 1994).

[45] L. Segreto, *Marte e Mercurio. Industria Bellica e Sviluppo Economico in Italia 1861-1940* (Milano, 1997).

characteristics of the Italian armaments industry: a dependence upon foreign technology, a lack of vertical integration, the impossibility of obtaining several important intermediate goods inside the country, strong links with the military and bureaucratic structures. However, he concluded that the sector, as a whole, played a positive role on the economy. This work is, to date, the best account of the development of the armaments sector in Italy; but it is not wholly satisfactory, because there is little use of either business or governmental primary sources, and, given its short length, many issues and questions which it raises are not addressed.

Paolo Ferrari's *Verso la Guerra* is another collection of essays which mainly deal with the armaments industry in Italy in the decades before 1914.[46] The majority of the articles focus on the activities of the Italian ministry of marine: Ferrari analyses the ministry's budget and calculates the amount of resources which were spent buying from armaments firms, the differences between the army's and the navy's involvement with private suppliers, and the power, or rather powerlessness, of the parliament in scrutinising the defence spending. Other articles deal with the impact of the Libyan War. Though Ferrari's essays are the result of meticulous research in government and parliamentary records, they lack a strong unifying framework.

A book which, despite its title, does not directly deal with the evolution of Italian armaments industry, but which is still relevant is Fabio Degli Esposti's *Le Armi Proprie. Spesa Pubblica e Sviluppo Industriale nell'Italia Liberale*.[47] In this book Degli Esposti offers a detailed analysis of Italian military budgets in the period 1861-1900. The volume focuses chiefly on the parliamentary debates inside the chamber of deputies over military expenditures, and, by offering the first proper examination of the notoriously opaque budgets of the military ministries, it represents an essential starting point for any analysis of the Italian armaments sector.

The second type of work on armaments companies published from the 1970s onwards is made up of business histories aiming at reconstructing the activities and operations of individual armaments firms where large holdings of documents have survived.[48] Trebilcock published a history of Vickers down to the First World War. The Armstrong company has been the subject of two volumes. The first is Kenneth Warren's *Armstrongs of Elswick*[49] – a rather traditional business history which focuses exclusively on the internal dynamics of the firm, and especially on the discussions inside the board, without giving much consideration to the external environment in

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46 P. Ferrari, *Verso la Guerra. L'Italia nella Corsa agli Armamenti 1884-1918* (Valdagno, 2003).

47 F. Degli Esposti, *Le Armi Proprie. Spesa Pubblica e Sviluppo Industriale nell'Italia Liberale* (Milano, 2006).

48 Several firms had already published official histories. These works offer limited critical analysis, but, usually, useful information. See, for example, J. D. Scott, *Vickers. A History* (London, 1962), and Sir A. Grant, *Steel and Ships. The History of John Brown's* (London, 1950).

49 K. Warren, *Armstrongs of Elswick: Growth in Engineering and Armaments to the Merger with Vickers* (Basingstoke, 1989).

which the firm operated. Some important topics, such as the Italian activities of Armstrong, are covered in a very limited and unsatisfactory way. Warren's volume, though, offers a detailed account of the evolution of the firm, and it is the only book which covers the entire life span of the company.

The second book is Marshall Bastable's *Arms and the State*.[50] Here the author's main interests are the social and cultural implications of technology. Consequently the predominant theme is how the technological dilemmas face by the British Navy (e.g. fast lightly-armed cruisers or slower but heavily protected battleships) were solved, and what impact these choices had on Armstrong. Bastable documents, consequently, the role that the military bureaucracy played in shaping the decisions of private contractors; but he is not interested in offering a general assessment of Armstrong's activities and operations. Another relevant book is Henrietta Heald's recent biography of Lord Armstrong, published for the two hundredth anniversary of Lord Armstrong's birth. The focus of the book is not on the businesses career of Armstrong, but it does offer several insights on his entrepreneurial capacities.[51]

Kenneth Warren has also published a volume on the history of Cammell Laird, another, smaller British firm involved in armaments and shipbuilding, adopting the same approach.[52] The history of Beardmore, a Scottish firm equally involved in armaments production has also been investigated. Apart from these books, there are a few articles about specific aspects of the activities of British armaments firms which will be referred to in the course of the thesis. Finally, Hugh Peebles's *Warshipbuilding on the Clyde* needs to be highlighted,[53] an investigation of the naval shipbuilding cluster of firms based in the Clyde area from the mid 19th century to the beginning of the Second World War. Peebles assesses not just the performance of individual firms, but also the trends shaping the entire industry.

Italian armaments firms too have been subject to historical scrutiny. Franco Bonelli's book on Terni is still regarded as a prime example of business history research and is the standard reference work on the history of the firm.[54] Ansaldo, the major Italian armaments firm before 1914, is, together with Fiat, the most studied firm in Italian history: a nine-volume history detailing its evolution from the mid 19th century to the late 1990s has recently been published.[55] Luciano Segreto and Maria Luogo have written articles respectively on Vickers and Armstrong's investments

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50 M. Bastable, *Arms and the State. Sir William Armstrong and the remaking of British Naval Power, 1854-1914* (Aldershot, 2004).

51 H. Heald, *William Armstrong: Magician of the North* (Newcastle upon Tyne, 2010)

52 K. Warren, *Steel, Ships and Men: Cammell Laird, 1824-1993* (Liverpool, 1998).

53 H. Peebles *Warshipbuilding on the Clyde* (Edinburgh, 1987).

54 F. Bonelli, *Storia di una Grande Impresa in Italia. La Terni dal 1884 al 1962* (Torino, 1975).

55 *Storia dell'Ansaldo* (Roma-Bari, 1994-2003) 9 volumes. The first three volumes cover the period of time relevant for this thesis.

in Italy.[56]

Finally, a publication which offers some important insights is Keith Krause's *Arms and the State: Pattern of Military Production and Trade*.[57] In it Krause develops a theoretical model of armaments trade based on a three-tier production system. At the top there are countries with the most advanced armaments industries which can manufacture the most sophisticated weaponry. In the middle, there are countries whose demand for armaments is mainly satisfied by domestic producers. These producers, however, rely for the most up to date know-how on technologies coming from countries belonging to the first group. The group at the bottom is made up of countries whose defence industries can only manufacture basic and unsophisticated goods, and which, therefore, need to import a large share of their armaments from the first and the second group of countries. The book is chiefly concerned with armaments trade after 1945, but, Krause's model, notwithstanding being static, and therefore unable to capture evolutionary processes, it is a useful heuristic tool to describe the armaments trade even before 1914.

This thesis will contribute to this debate by first and foremost offering a reconstruction of the development of the Italian and British private armaments sectors before 1914. The business-oriented works have increased our understanding of the industrial experiences of many armaments firms but, as this review of the historiography has shown, there is no work which has tried to offer such a general assessment. This thesis will focus especially on the business side of the rise of private armaments firms in the two countries. These are other aspects of the rise of the private armaments industry (technological dynamics, relationships with bureaucracies, etc.), but they cannot be fully investigated before a better understanding of business practice. This thesis aims to clarify two fundamental points which still have not been satisfactorily elucidated. The first is why a private armaments industry developed in both countries, supplanting to a large extent the production of public establishments in the process. The second is the degree of similarity between the Italian and the British experiences.

Sources

This thesis makes use of a variety of sources. They can be divided into four categories:

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[56] M. Luongo ‘Lo Stabilimento Armstrong di Pozzuoli’, *Revue d'Histoire de la Banque* 34-35 (1987), 128-263, and L. Segreto, ‘More trouble than profit: Vickers' investments in Italy 1906-39’, *Business History* 27 (1985), 316-337.

[57] K. Krause, *Arms and the State: Pattern of Military Production and Trade* (Cambridge, 1992).

business records, government documents, journalistic reports and technical publications.

Before 1914 armaments firms were among the largest firms in almost every big European state. This, together with the fact that many armaments firms which operated before the First World War are still active, although usually under different brands and often as part of conglomerates, facilitated the preservation of their archives.[58] In Britain, Armstrong's and Vickers's records have been well preserved and they are fully accessible to scholars. Armstrong's records, held in the Tyne & Wear Archives in Newcastle-upon-Tyne, have been preserved quite integrally. Vickers's archive is hosted by the Archives of the University of Cambridge Library. For the years before 1914 documentation is more fragmented than for Armstrong, but the surviving material is large enough to allow a reconstruction of the firm's activities before the Great War. The records of other armaments firms – John Brown, Cammell Laird, Beardmore, etc. – are all less rich and in some cases missing.

In Italy the level of preservation of the records of the major armaments companies varies considerably. Ansaldo's records have been carefully preserved by the Ansaldo Foundation, a body set up by the company with the aim to safeguard them for the use of scholars. The Ansaldo Foundation has decided to maintain the documents in the order in which they were originally organised by the Perrone family, the major shareholders of Ansaldo in the period 1903-1921. As a result, browsing through the papers is not always an easy task, given that the Perrone usually put in the same box documents about different topics (also not connected with Ansaldo) and without any precise chronology. The Ansaldo Foundation, however, has created a detailed multi volume paper catalogue which is very helpful, although it is not easy to navigate. Terni's records are preserved in the Archivio di Stato of Terni. They suffer from two problems: the first is that many records have simply disappeared, the second that the Archivio di Stato has not managed to produce a decent paper catalogue of the surviving ones. These facts hugely complicate research. The records of some other firms, such as Orlando and Odero shipbuilding firms, have been preserved only in minimal amount. In the case of some other companies, such as Armstrong's Italian branch, the relevant records are simply missing (apart from a commemorative volume published by the firm in 1911).[59]

Government records are the second category of documents which have been used. British military budgets – the annual naval and army estimates – are rich sources of information. For instance, they usually break down the cost of military hardware among its major components. Documents produced from the War Office and the Admiralty have been also used. In addition, reports produced by select committees or parliamentary commissions which investigated specific

[58] For example, the armaments business of Vickers, which merged with Armstrong in the late 1920s, now belongs to BAE; the military assets of Ansaldo, Terni and Vickers-Terni are now part of Finmeccanica.

[59] *Lo Stabilimento Armstrong di Pozzuoli dal 1886 al 1911* (Bergamo, 1911).

aspects of the armaments business or of the British government's procurement policies have been consulted. The fact that many British official documents have been digitalised is a considerable advantage.

By comparison the equivalent Italian records are less rich and far less accessible. The relationships which existed between the executive, the military administration and the parliament in Italy were different from those in Britain. The Italian parliament did not have the right to be fully informed on the military and strategic decisions taken by the king, the government and the armed forces. The Savoy kings strongly resisted the idea that the armed forces might be treated as any other piece of the state organisation. Indeed, a special bond existed between the king and the military, which made the armed forces the final guarantor of the stability and unity of the country. It is noticeable that all but a few ministers of the army and of the navy in office between 1861 and 1914 were generals or admirals. The Italian parliament was required to approve the yearly military budget, but little information was disclosed in the process. The only occasions on which MPs and the country gained a better understanding of the organisation of the procurement system for the armed forces, was when a parliamentary inquiry on naval expenditures (1903-05) – whose records are extensively used here – and a parliamentary inquiry on the army (1907-1908) were created. The second problem is that many documents produced by the Italian military ministries have not been sent to the Archivio Centrale dello Stato in Rome. At the same time documents which have been sent there have only partially been reorganised. The catalogues listing these records do not provide much help, because they generally report only the title of the first document inside each box. Given that there are hundreds of boxes, each containing up to tens of files, this is a significant stumbling block.[60] Luckily, the documents produced by the general direction for armaments of the ministry of the navy in the 1880s, a crucial period for the development of the Italian armaments industry, have been recently reorganised and are therefore much easier to use. Parliamentary documents are starting to be digitalised. However, access is relatively easy to gain, and the level of preservation is very good.

The third category of sources is made up of journal and newspapers articles. The digitalised archive of *The Times* is very useful. Many articles, often very detailed, were published on new warships, improvements in artillery, etc. Similarly, the archives of other publications such as *The Financial Times* and *The Economist* have been used. By contrast, in Italy, before 1914, there was no newspaper which enjoyed national circulation. Moreover, only *La Stampa*, a newspaper based in Turin, has digitalised its pre-1914 archive. The *Corriere della Sera*'s archive, for example, is still

[60] On the difficulty of using these records see F. Degli Esposti, 'Stabilimenti Industriali o Falansteri? La Lunga Parabola degli Arsenali (1800-1930', N. Labanca and P. P. Poggio (eds.), *Storie di Armi* (Milano, 2009), 51-56.

not accessible.

Trade journals are the fourth category of sources. In Britain the monthly *Arms and Explosives* covered the armaments industry, although it was especially focused on small arms and sporting guns. In Italy the relevant publication is the *Rivista Marittima*, the official journal of the Italian navy.

Finally, technical details and data on warships come from the most authoritative works on vessels launched before 1914: Oskar Parkes's book on British battleships, *Conway's All the World Fighting Ships*, *Jane's Fighting Ships*, and Giorgio Giorgerini and Augusto Nani's volumes on Italian vessels.[61] To avoid multiple references, data sources are reported in footnote only when they do not come from one of these volumes.

Chapter synopses

The thesis is structured as follows. Chapter I explores the evolution of the British armaments industry from the late 1850s to 1880. The Crimean War and the introduction of ironclad vessels generated a new interest for the design of more effective artillery. William Armstrong, a Newcastle businessman, gained government approval for an innovative prototype he devised. Production of the new guns was carried out both in the Royal Gun Factories and at a private plant specifically created in Elswick. When Armstrong's contract with the government was prematurely terminated, Elswick found itself in the position of having to look for new markets. For the next two decades government arsenals and yards supplied the British armed forces with most of its armaments, buying from private suppliers only armour plates. Armstrong, which was the firm mostly involved in armaments making, relied quite exclusively on foreign markets. Its high-quality production was sought after by countries which were in no position to manufacture sophisticated artillery at home.

Chapter II investigates the Italian armaments industry during the same period. Immediately after political unification, Italy wanted to rapidly modernise its armed forces. Government arsenals and domestic firms, however, were in no position to produce the most complex goods such as large guns and armour plates. Crucial military hardware and also entire vessels were therefore purchased

[61] O. Parkes, *British Battleships from "Warrior" to "Vanguard". A History of Design, Construction and Armaments* (London, 1957); *Conway's All the World Fighting Ships, 1860-1905* (London, 1976); *Conway's All the World Fighting Ships, 1906-1921* (London, 1985); F. T. Jane, *Jane's Fighting Ships of World War I* (London, 1990); G. Giorgerini, G. and A. Nani, *Le Navi di Linea Italiane. 1861-61* (Roma, 1962); id., *Gli Incrociatori Italiani 1861-1964* (Roma, 1964); id., *Almanacco Storico delle Navi Militari Italiane (1861-1995)* (Roma, 1996).

abroad. It was only in the course of the 1870s that a small group of Italian firms was able to secure a more stable position as suppliers of components to the navy, although the country still relied heavily on imports for all key components.

Chapter III deals with the development of the British armaments industry in the period from the early 1880s to 1897. These years saw the private sector gaining a larger role in the supply of armaments to the British government. This change was caused by new political and economic circumstances. Naval scares in 1884 and 1888 led to a rapid expansion of the British naval budget. The demand for new vessels could be satisfied only thanks to contracts awarded to private firms. At the same time, the impact of the negative business cycle led several firms, chiefly the Vickers Company, to enter the armaments business.

Chapter IV analyses the Italian armaments industry in the period 1800-1900. During the 1880s the Italian naval budget grew remarkably, resulting in large orders for national producers as well as for foreign suppliers. A group of entrepreneurs created the Terni company, with the financial backing of the navy, in order to start domestic production of armour plates. In contrast, the 1890s saw stagnating naval budgets. This fact had a negative impact on Italian armaments companies which, however, at the end of the century, was able to enter the international armaments trade selling cruisers to Argentina, Spain and Japan.

Chapter V details the creation of the Armstrong's Italian branch in Pozzuoli. Armstrong decided to create it to avoid losing the important Italian market: the Italian navy had made clear its desire that the firm started its production in Italy. Pozzuoli's results remained satisfactory for years, but this venture was probably the largest foreign direct investment made by any British armaments firms before 1914, and thus it deserves to be studied.

Chapter VI presents the evolution of the British armaments industry in the period 1897-1914. While many scholars saw in the introduction of dreadnought battleships in 1906 a turning point, the British private armaments industry did not change its internal organisation because of that. It was the wave of mergers and acquisitions which occurred in the late 1890s which had a lasting impact on the industry.

Chapter VII deals with the Italian armaments industry in the period 1900-1914. In these years, Italian armaments firms pursued strategies of vertical integration. To start some productions, however, external help and know-how was required. Terni created a joint-venture with Vickers for the production of guns, while Ansaldo entered into a temporary alliance with Armstrong. In the early 1910s, Italian armaments firms eventually acquired the capacity to produce all the major components of warships: hulls, armour plates and guns.

The Conclusion summarizes the main findings of the work and considers their broader

implications. The combination between the rapid evolution of military technology and specific historical events resulted in the growth of large private armaments companies in both countries. At the same time, however, the conclusion highlights how the Italian and British experiences were different in several important aspects, that is the relationship between governments and private companies, the different technological capacities, and the amount of competition between private armaments firms.

Chapter I

The Beginning of the British Armaments Industry, c. 1850s–1880

This chapter deals with the development of the British armaments industry from the 1850s to the early 1880s. By the mid-19th century, ordnance production in Britain was a virtual monopoly in the hands of the Royal Gun Factory at Woolwich. The mixed performance of British guns during the Crimean War, and, subsequently, the introduction of the first ironclad vessels generated a demand for better artillery. William Armstrong prevailed among the many engineers and inventors who submitted their designs to the War Office, and his revolutionary gun was temporarily adopted by the British armed forces. In the early 1860s, however, after various disagreements with the government, Armstrong left public service and set up his own ordnance firm in Elswick, Newcastle. The foundation of Armstrong's company signalled the beginning of a new phase in the history of British armaments industry, a phase characterised by the growing role of private companies. It is therefore necessary to analyse in depth the circumstances surrounding Armstrong's decision to enter the armament business.

From the early 1860s to the beginning of the 1880s navies around the world completed their transition from wooden vessels to ironclads. There was a lack of uniformity in design, however, and warships of various sizes and shapes were built. Technology evolved rapidly, but without a generally agreement over the direction in which naval design should move. What was clear, however, was that thicker armour plates were needed to withstand the shots of guns which were becoming larger and more powerful. Improvement in artillery, in turn, stimulated improvements in ship's protection.

In the two decades covered here, the British naval budget remained at a constant level, at little more than £10 million a year: the absence of any significant long-term external threat limited the pressure for additional spending. The largest share of the part of the defence budget devoted to armaments procurement was spent to patronise the government establishments: Woolwich supplied the artillery, and the Navy-owned arsenals built the majority of warships (but the engines were

bought from private firms, as it had happened since the introduction of steam). At the same time, however, a small number of private firms involved in armaments production started to emerge. These firms can be divided into two groups: on the one side there was Armstrong which sold artillery predominantly to foreign governments; on the other side, two Sheffield-based iron firms, Cammell and John Brown, formed a duopoly which supplied armour plates for the Royal Navy as well as to foreign governments.

The chapter is organised as follows: the first section explores the motives and circumstances behind Armstrong's decision to move into gun manufacturing. The second considers the British naval budget and the evolution of naval technology in the years 1860-1880. The third deals with the creation of the Armstrong Company and its growth from being a firm with no domestic market in the early 1860s, to be the leading private maker of naval armaments in the world. The fourth considers the evolution of the Sheffield iron companies making armour plates.

1.1 *The foundation of Armstrong and the private armaments industry (1854-1863).*

By 1850, artillery production in Britain was mostly undertaken at the Royal Ordnance Factory at Woolwich, which was supervised by the Board of Ordnance, a government department independent from both the War Office and the Admiralty – although it was mainly manned by Army officers – which was in charge of supplying guns to the Royal Navy and the Army.

After 1815, cast iron smoothbore muzzle-loading guns remained the standard pieces of ordnance of the British armed forces, as they had been for centuries. This fact might appear surprising in light of the rapid technological innovation which, in the same period, characterised so many fields, such as rail engineering, iron metallurgy and steam propulsion. Several reasons, however, explain this stasis. In the period from 1815 to the Crimean War British armed forces were not tested in any serious conflict. The Army was chiefly occupied in colonial “small wars”, and the Navy enjoyed the superiority which she had gained at Trafalgar – a superiority not based on technology, but on better organisational capabilities.[1] In these decades the Royal Navy fought just one significant naval engagement, the battle of Navarino in 1827, and that was against the inferior Turkish fleet.[2]

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1 P. Kennedy, *The Rise and Fall of British Naval Mastery* (London, 1976), 49.
2 C. M. Woodhouse, *The Battle of Navarino* (London, 1965), 70.

In addition, during this period military hierarchies were conspicuously conservative. The Army was dominated by the Duke of Wellington who maintained virtually unchanged the Army's organisation and structures of the time of Waterloo. The Royal Navy was more keen on investigating novelties, but her interest was chiefly focused on the use of steam power, rather than in artillery. The Royal Navy was quite happy with larger and refined versions of old smoothbore guns. British governments were quite happy with their defence establishment, military preparedness not ranking among the most pressing issues of the day. Thus, during the period from the end of the Napoleonic Wars to the Crimean War, there were neither external nor internal pressures toward radical technical innovation.

This is illustrated by the adoption of the practice of "reaming-out" old guns, that is the process of reboring old smoothbore guns to enlarge their barrels up to a larger calibre. This made the guns more powerful because they could fire larger cannon balls. Old pieces of ordnance could then be retained in service, reducing the need to cast new guns and, consequently, limiting defence expenditure.[3] The only innovation which occurred in these years was the adoption of explosive shells. Shot by mortars, shells had been in use for centuries in siege warfare. Mortars' bell-shaped trajectory, however, made them totally unsuitable for naval fighting. At the beginning of the 1820s the French general Henri-Joseph Paixhans designed an explosive shells which could be shot from guns, notwithstanding their flat trajectory.[4]

The catalyst of change was the Crimean War. In 1853 Britain, France and Piedmont allied to support the Ottoman Empire against Russia. Britain wanted to check Russia's ambitions in the Balkans and to prevent its access to the Mediterranean through the Turkish straits.[5] The Crimean War highlighted the British military's many problems.[6] The logistics was especially poor: 80% of British casualties died from sickness or disease.[7] What is relevant here is the performance of the British artillery. The correspondent of the *Times* vividly described how, during the battle of Inkerman (5 November 1854), the British forces avoided being routed by the Russians thanks to the intervention of two 18 pound guns. However, because of their massive weight, it took three hours for one hundred and fifty men to drag the guns in position.[8] After the Crimean War the Board of Ordnance was merged with the War Office and a Naval Ordnance Department was created inside

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3 H. Douglas, *A Treaties on Naval Gunnery* (London, 1853), 181-184.
4 J. Boudriot, *Vaisseaux et Frégates sous la Restauration et la Monarchie de Juillet* (Vinçennes, 1987), 65.
5 A. J. P. Taylor *The Struggle of Mastery in Europe* (Oxford, 1954), 60-82.
6 T. Royle, *Crimea: the Great Crimean War* (New York, 2000), 502-504; W. Baumgart, *The Crimean War, 1853-1856* (London, 1999), 78-81.
7 O. Figes, *Crimea. The Last Crusade* (London, 2010), 467.
8 *The Times* 7 November 1854, 6; 4 December 1854, 7-8.

the War Office to take care of the artillery need of the Royal Navy. Thus the Army became responsible for the supply of guns for the Navy until, in 1891, a bureaucratic reorganisation led to the creation of an autonomous Ordnance Department inside the Admiralty.

It was the journalistic reports coming from Crimea which led William Armstrong, a brilliant solicitor-turned-engineer, to design of a better kind of ordnance.[9] William Armstrong was born in Newcastle in 1810. His father was a rich merchant involved in the grain trade and in the political life of the community. Armstrong was trained in the law in London, but he was much more interested in engineering.[10] He improved his technical skills by spending hours in the mechanical shop owned by his father-in-law.

Armstrong's first entrepreneurial venture started in 1847 when, together with several partners, he established the W. G. Armstrong & Company to manufacture cranes. He had recently patented a system to lift weights using hydraulic force that exploited a device he had invented, the "accumulator", which multiplies the hydraulic power. The enterprise was a very successful: Armstrong's cranes were soon sold to mining companies, railways, ports and yards, and were also exported.[11] This technology could be used in many fields, and it was applied to bascule bridges and movable platforms (and, later on, gun mountings).

Two important features of Armstrong's first industrial venture need to be highlighted because they subsequently had an impact on his artillery business. First, the role of export markets. Cranes and guns are obviously different products. Guns are purchased mainly by governments, while cranes have a much larger market. Both cranes and artillery, however, share a key feature: they are goods whose technology and reliability are more important than their initial price. Armstrong's cranes were a technologically advanced product and customers were happy to pay handsomely, given their superior performance. Thus, it is not surprising that part of production was exported: European countries were entering a period of rapid growth and their industrial plants and infrastructures were being modernised and upgraded. This fact meant that Armstrong and the company's management (the majority of whose members – people like George Cruddas and George Hutchison – later joined Armstrong in the armament business), came into contact with foreign customers. This experience proved useful when in 1863, as explained below, William Armstrong

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9 S. Rendel, *The Personal Papers of Lord Rendel* (London, 1931), 269.

10 H. Heald, *William Armstrong, Magician of the North* (Newcastle upon Tyne, 2010), 25.

11 The Venice Arsenal acquired a crane which is one of the few exemplars still surviving nowadays, see C. Menichelli, A. Lionello and A. Bovolenta, 'La Gru idraulica Armstrong dell'Arsenale di Venezia', paper published on the website of the office for the preservations of artistic monuments in Venice http://www.soprintendenza.venezia.beniculturali.it/soprive/restauri/Cantieri/la-gru-idraulica-armstrong-dell2019arsenale-di-venezia (accessed 3 August 2011).

would find himself with a fully equipped gun factory but without a domestic market.

Second, the hydraulic technology itself played a crucial role in the initial success of Armstrong's armaments business. Starting from the 1870s, naval artillery underwent a period of radical redesign: larger guns were introduced and the gunners' time-honoured task of physically moving and pointing became impossible to perform. Armstrong's past experience proved decisive because his firm developed highly effective gun mountings based on hydraulic technology as those of the cranes. Whereas manufacturing gun barrels was relatively straightforward, making gun mountings was much more complex and Armstrong retained for decades a competitive edge precisely because of its ability to produce superior mountings.

In 1854 Armstrong was persuaded to apply his engineering skills to the challenge of designing a better kind of artillery by his friend James Rendel, an expert in hydraulic engineering.[12] Armstrong noted that "it was a scandal that the military engineers are some thirty or forty years behind the civil engineers".[13] Armstrong and Rendel had worked together for the enlargement of the port of Grimsby, Armstrong devising the hydraulic system used to power the lock gates and the cranes of the port.[14] The connection between the Armstrong and Rendel families was strong and three of Rendel's sons would later join the management of Armstrong's armaments company and one of them, Stuart Rendel, eventually became, after the death of Armstrong, one of the largest shareholders of the firm.

Armstrong was not, however, the only engineer who tried to design a better piece of artillery: the Crimean War generated a wave of interest, and the War Office received hundreds of proposals by inventors who claimed to have devised revolutionary new ordnance.[15] The War Office, recognising the limits of the current British artillery, offered grants to support further studies of the most promising designs. Armstrong submitted his own "Armstrong gun", which had many features which made it revolutionary. First, it was breech-loading. This was not in itself an innovation since the first pieces of artillery used in Europe were breech-loading. For centuries, however, muzzle-loaders were preferred because it was impossible to built a breech mechanism strong enough to withstand ignition. Innovations in metallurgy and engineering allowed a return to breech-loading. Armstrong designed a new mechanism to seal the breach: a vertical sliding block, called "vent-

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12 M. R. Lane, 'Rendel, James Meadow', *ODNB*.

13 Rendel, *Papers*, 269-70

14 The 61 meter tall Grimsby dock tower which hosted the hydraulic reserve needed to generate the pressures still exists today.

15 M. J. Bastable, *Arms and the state. Sir William Armstrong and the Remaking of British Naval Power, 1854-1914* (Aldershot, 2004), 26

piece", to which a conical plug was attached to seal the breech. The vent-piece was kept in place by a screw which needed to be tightened before firing.[16]

The second key feature was the rifled barrel. As a consequence of rifling cannonballs had to be replaced by elongated projectiles able to "travel" along the grooves inside the barrel. A rifled barrel made the gun more precise because rifling stabilized the projectile, giving it a gyroscopic spin, and improving its aerodynamics and accuracy. In addition, rifling also gave the gun a longer range because the elongated projectile faced less air resistance. Rifling was not in itself an innovation: rifled barrels had been used in portable firearms for more than a century; but rifling had proved to be difficult to introduce in artillery. Because of its brittleness, cast iron was difficult to rifle, often breaking in the process. Rifling, however, offered so many advantages, that many prototypes of rifled guns were developed from the 1820s onwards, but none proved good enough to be adopted.[17] Armstrong solved the problem, rifling a steel tube which formed the inner part of the barrel.

Third, the gun was manufactured using a combination of steel and wrought iron to achieve a satisfactory mix of resistance and toughness. The internal rifled barrel was made in steel. Then a second tube of a smaller diameter made of wrought iron was heated to make it expand and it was forced around the steel barrel. Cooling down, it shrank around the internal tube exercising a pressure towards the core of the gun which compensated for the pressure generated by the explosion caused by firing the gun. Additional wrought-iron tubes were shrunk, especially around the breech, where the force of the explosion was stronger (in this period gunpowder was still in use which burnt instantly, thus the strength of the explosion was not uniform along the entire length of the barrel, but was stronger at the breech and weaker at the muzzle), to reinforce the gun. Thus guns built according to this "Armstrong construction system" had a peculiar telescopic shape caused by the fact that additional layers of iron were used to reinforce the breech.

Fourth, Armstrong's design was "universal", in the sense that the basic idea behind it could be replicated for guns of every sizes. Armstrong initially built a small 3 pounder gun but the same principles allowed for the design and manufacture of artillery of much larger calibre, as in fact occurred.

Fifth, Armstrong did not just offer the War Office a project, but submitted a complete and

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[16] Armstrong himself described his gun in a document prepared for the War Office: N.A., W.O. 33/11 *Report on the Construction of Wrought Iron Field Guns*, 14 July 1855.

[17] F. Taylor, *Rifled Field Pieces. A Short Note of What is Known of the New Field Artillery of Europe* (Washington, 1862), 7-32.

perfectly functioning prototype. This made a positive impression: instead of having to devote months to refining, implementing and, afterwards, improving a project which existed only on paper, the War Office could examine the finished article. This was another advantage that Armstrong gained from his previous business career: he had unlimited access to a mechanical plant and could rely on the technical skills of his workers and on his own personal fortune to prepare and refine his gun.

The Armstrong gun was a remarkable technological feat, and an impressive example of entrepreneurial ingenuity. Armstrong's breakthrough was to combine novelties which he had devised, with innovations which other people had proposed, in order to design a new product. The new gun was easy to handle, because it was lighter than a comparable bronze one, more precise and with a longer range than a cast iron smoothbores, and its elongated shells had a higher penetration power than cannonballs. The gun's performance in trial was remarkable in terms of accuracy, power and range – so much so that Armstrong's was soon asked to submit designs for several larger guns.[18]

Among the projects submitted to the War Office, there was one other which attracted good reviews: Joseph Whitworth's. Whitworth was already famous for his work on precision machine tools.[19] It is no coincidence that the two best designs came from established entrepreneurs had the experience and the resources to pursue their projects. Whitworth's project had some features in common with Armstrong's, but was quite different in other respects. Whitworth too proposed a breech-loading gun with a rifled barrel, but in his design the rifling had a hexagonal shape. Another major difference was that Whitworth's gun was made using exclusively cast iron.[20] The two inventors soon developed a fierce rivalry and undertook a series of trials which were widely reported in the press to try to demonstrate the superiority of their own gun.[21] Eventually, in 1858, Armstrong's design was approved by the War Office. The Army adopted Armstrong's guns with a variety of calibres as its field artillery, while the Navy adopted an 110 pound gun to replace the old smoothbore 68 pounders.

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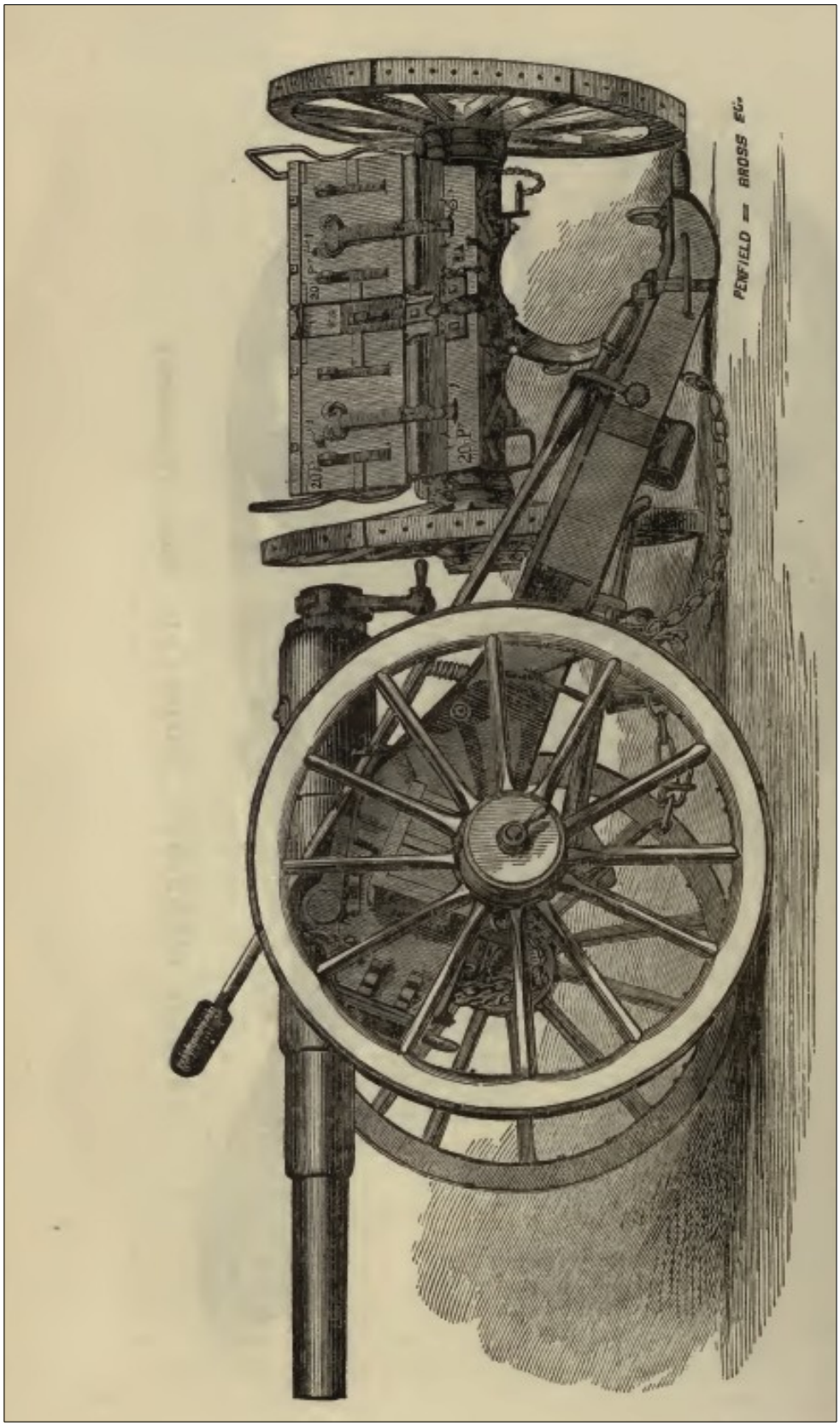
18 *Confidential Report* W.O. 33/9.

19 N. Atkinson, *Sir Joseph Whitworth: 'The World's Best Mechanician'* (Gloucester, 1996) is a general biography. A. E. Musson, 'Joseph Whitworth and the Growth of Mass-production Engineering' *Business History* 17 (1975), 109–49, is a more business-oriented assessment of Whitworth's activities.

20 All other cast iron guns were rejected, *Report of Ordnance Select Committee on Competitive Rifled Cast-iron Guns,* HCPP (1863).

21 M. J. Bastable, 'From Breechloaders to Monster Guns: Sir William Armstrong and the Invention of Modern Artillery, 1854-1880', *Technology and Culture* 33 (1992), 213-247.

Figure 1.1: Armstrong's 20 pounder gun.



Source: A. L Holley, *A Treatise on Ordnance and Armor* (New York, 1865), 21.

A new potential military threat gave urgency to the rearmament process. Relations between Britain and France soured after the Crimean War. In 1858 the French Navy launched *La Gloire*, the first ocean-going ironclad vessel to enter into service: the aim was that of nullifying overnight the Royal Navy's quantitative superiority in vessels by gaining a qualitative superiority. *La Gloire*'s wooden hull was covered by iron plates of 4.5 inches, a protection thick enough to withstand the shots of the 68 pounder smoothbore gun, the largest and more powerful piece of ordnance the Royal Navy had then at its disposal.[22] Overnight, Britain seemed in danger of losing its naval superiority. With the benefit of hindsight, the French threat was less serious than it appeared: France did not have the industrial resources to build a fleet of ironclads faster than Britain. Still, the introduction of ironclads revolutionised naval warfare by suddently making wooden vessels obsolete.

The British response came in the shape of HMS *Warrior* which entered into service in 1861, just one year after *La Gloire* had been commissioned. HMS *Warrior* was even more revolutionary than *La Gloire*, because it was not just protected by metal plates, but its hull was also made of iron. It outclassed its French counterpart in speed, displacement, armour and gunnery.[23] To decide with what guns to arm the *Warrior*, in September 1858 the War Office set up a Special Committee on Rifled Ordnance, whose secretary was artillery captain Andrew Noble. Two years later he left the Army to join Armstrong's firm. The Special Committee compared once again Armstrong's and Whitworth's guns. Armstrong's prevailed for a second time: HMS *Warrior* was to carry a mix of old 68-pound guns and 10 new rifled 110-pound Armstrong guns.

In order to re-equip both the Army and the Navy swiftly with the new rifled artillery, the government followed its traditional pattern of procurement in moments of crisis: it enlisted the help of the private sector to maximize production. Armstrong's partners in the Elswick Engine Works – George Cruddas, Richard Lambert and George Rendel – had already set up a different firm, the Elswick Ordnance Company (EOC) to undertake the manufacture of guns. Armstrong and the government arrived at a compromise: Armstrong would donate the patent covering the gun's design to the country, hence renouncing the right to exploit it commercially.[24] In exchange, the government guaranteed the money spent on establishing the Elswick Ordnance Company for up to £50,000,[25] and signed a ten-year contract for the supply of guns from it. Orders for the guns were split between Woolwich and Elswick. In addition, Armstrong was knighted and – a more material reward – he

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22 J. P. Baxter, *The Introduction of the Ironclad Warship* (Cambridge, 1933), 123-126.

23 W. Brownlee, *Warrior: the First Modern Battleship* (Cambridge, 1985) offers a detailed description of it. The Maritime Trust saved the vessel from being scrapped, and now HMS *Warrior* is a museum ship in Portsmouth.

24 The text of this document is in *Report of the Committee on Military Organization*, HCPP (1862), 663.

25 Id., 664.

was nominated Engineer for Rifled Ordnance – later Superintendent of the Royal Gun Factory – a newly created senior managerial position at Woolwich, with an annual salary of £2,000.[26] Figure 1.2 below shows the percentage of orders divided according to the place of manufacture for a selection of guns representing more than 90% of the entire production in the years 1858-1863.

Figure 1.2: orders for guns received by Elswick and Woolwich, for different calibres (1858-1863).

Ordnance	Elswick	Woolwich	Total number
300-pound gun	66%	33%	12
110-pound gun	24%	76%	1021
40-pound gun	70%	30%	848
20-pound gun	-	100%	319
12-pound gun	10%	90%	691
9-pound gun	-	100%	194
6-pound gun	-	100%	94

Source: *Return of the Numbers of Armstrong's Guns Supplied to the Government from Elswick and Woolwich*, HCPP (1863), 2-3.

Woolwich built all the small calibre guns – the cheapest and easiest to manufacture – and a prominent share for the 110-pound breech-loading guns, the new Royal Navy standard gun. Elswick specialised in the medium calibre guns (the 40 pounder) and in the very large ones, such as the experimental 300 pounder. Table 1.2, however, does not tell the whole story. Elswick supplied almost all the trial guns of various calibres which were tested. Each of these pieces was, obviously, more costly than a standard piece of. For instance, a single prototype for a very large 600 muzzle-loading gun cost £4,000. It seems possible to detect a pattern: Elswick devoted itself to the development and refining of guns, and to the manufacture of the most complex ones, Woolwich manufactured the pieces that had already been tested. The second field where Elswick was pre-eminent was in the production of shots, shells and fuses. Up to May 1863 the EOC had delivered material valued at £414,194, whereas Woolwich's output was equal to £142,930. In general, economy of experience and more refined production processes contributed to a reduction of the

[26] Id., 662.

costs, for instance, the price for the 110-pound guns halved from around £1,200 to near £600 in few years. To summarize, during the period 1858-1865 Woolwich's various departments produced about £1,785,000 worth of material. The total payments received by Elswick was £1,113,417. Figure 1.3 shows payments according to the years they were received.

Figure 1.3: Payments received by Elswick in the period 1858-1865.

Year	Amount (£)	% of total
1858-59	7,868	0.71%
1859-60	31,551	2.83%
1860-61	398,327	35.78%
1861-62	397,785	35.73%
1862-63	188,782	16.96%
1863-64	11,097	1.00%
1864-65	78,007	7.00%
Total	1,113,417	100.00%

Source: *Report from the Select Committee on Ordnance*, HCPP (1863), 527, and *Return of Expenses Incurred on all Class of Armstrong's Gun*, HCPP (1865), 2.

Figure 1.3 shows how the payments Elswick received peaked during a two-year period. Because the company was paid after the guns were delivered and successfully tested, payments tracked production, with only a limited temporal shift. The bulk of the production – 86% of the total – occurred in the period from 1860 to 1862. From 1859-60 to 1860-61 production increased by more than ten times. This put huge pressure on Elswick which had to rapidly increase its facilities, buy new machineries and recruit more workers.

In 1862 the government terminated the contract with Elswick and, consequently, payments plummeted. From 1863 onwards, Elswick was delivering only guns and other materials which had been ordered before 1863. Why did the British government, so eager to modernise its artillery, end the contract with Elswick in advance? The first reason was that British relations with France improved after the signature in 1860 of the Cobden-Chevalier agreement. This did not mean the end of the re-equipping of the armed forces, but reduced the scope for additional orders. A second reason was that Armstrong and his guns started to attract a good deal of criticism. Critics focused on

two separate points: the performance of the new guns, and the agreement signed by the government with Elswick. The ability of Armstrong guns' breech-loading mechanisms to withstand explosions was questioned. The vent-pieces employed in the smaller guns worked perfectly, but, in the more powerful 110 pounders, the same mechanism, after several detonations, was prone to break and, sometimes, to blow out. Armstrong responded with a letter published by *The Times* on the 27 November 1861, but rumours persisted. It was undeniable, however, that handling breech-loading guns required more attention and care than muzzle-loading. Moreover, the 110 pounder was not able to penetrate the 4.5 inches of the protective plates of *La Gloire*. This criticism was unfair, though, given that the 110 pounder had been developed before the French ironclad had entered in service.

Another line of criticism was over the contract signed with the Elswick Ordnance Works. Critics pointed to the fact that Woolwich could manufacture guns more cheaply than Elswick and thus the government was wasting money by awarding a contract to the private company. The fact that Armstrong was a government employee while, at the same time, a group of his friends was making money thanks to his invention, made his position somewhat suspicious. Moreover, Armstrong's position was likely resented by many inside Woolwich, who disliked the fact that a civilian was holding such a prominent position. This can be inferred from the fact that documents which seemed to point to Elswick's excessive prices were leaked from the War Office.[27] A careful examination of the numbers found in these documents, however, points to a different conclusion or, at least, significantly reduces the extent of the alleged overpricing. Figure 1.4 shows data about the cost structure of the 110 pounder guns made in Elswick and Woolwich.

A simple numerical comparison would be misleading, because it is not possible to ascertain the accounting practices followed by the two different plants. Woolwich's habit of not considering depreciation and capital disbursements among its costs gave a misleading impression of its costs. Moreover, price comparison does not account for any qualitative difference, and evidence about that is contradictory. Like for like comparison is therefore only possible for the first two categories of costs. Labour and materials cost at Woolwich were 7.8 % higher that in Newcastle. This difference, however, is easily explained by the fact that the salary was higher in London than in the North East. Both Elswick and Woolwich had to purchase steel on the market, hence it is unlikely that they paid very different prices for it. Also if data are taken at face value, Armstrong's profit would be equal to 7.6% of the contract price, not an especially large margin.

[27] See for instance data from *Report from the Select Committee on Ordnance*, HCPP (1862), 151.

Figure 1.4: Cost data for 110 pounder gun made in Elswick and Woolwich (in current pound).

Costs	Elswick	Woolwich
Labour and materials	268	289
Contingencies of proofs and other charges	134	136
Depreciation (10% of the value of machineries)	37	-
Interests on capital employed per gun	23	-
Total costs	**462**	**425**
Contract price	500	-
Profit	38	-

Source: *Report from the Select Committee on Ordnance*, HCPP (1862), 152

The decisive blow which weakened Armstrong's position, however, was technological. In 1862 major William Palliser patented a system to transform old muzzle-loading smoothbore guns into muzzle-loading rifled guns.[28] Palliser's system was based on the same principle as Armstrong's construction method: a wrought iron rifled barrel was inserted into the old cast iron smoothbore guns, which had been heated to expand. The result was that the large stock of smoothbore guns could now be transformed into more effective rifled guns and return to service, saving the War Office a good deal of money. Eventually, in 1868, citing high maintenance costs and uneven performance, the War Office retired all breech-loading guns used by the Royal Navy and the Army, issuing only muzzle-loading rifled guns.[29] Such a decision resulted in plenty of work for Woolwich: the demand for war stores during the Crimean War had resulted in a much enlarged Royal Arsenal, and the government was pleased to find a way to keep the large investments made during the 1850s productive.[30]

The contract with Elswick was thus cancelled and in January 1863 the government liquidated Elswick with £85,000 as compensation for the premature termination of the agreement.[31] Armstrong's position at Woolwich become then untenable and on 5 February 1863 he resigned from

[28] E. M. Loyd rev. G. Hudson, 'Palliser, Sir William', *ODNB*.
[29] E. M. Spiers, *The Late Victoria Army, 1868-1902* (Manchester, 1992), 241.
[30] O. F. G. Hogg, *The Royal Arsenal* (London, 1963), 771-786.
[31] *Report from the Select Committee on Ordnance*, HCPP (1863), 599.

his position.[32] Later the same year, the Elswick Ordnance Company merged with the Elswick Engine Works to create the Sir W. G. Armstrong Company. The new company faced a difficult moment. The artillery business had lost the only customer it had ever had and there was no prospect that the British Government would reverse its decision in the near future. The only chance of survival for the artillery business was to find new customers abroad.

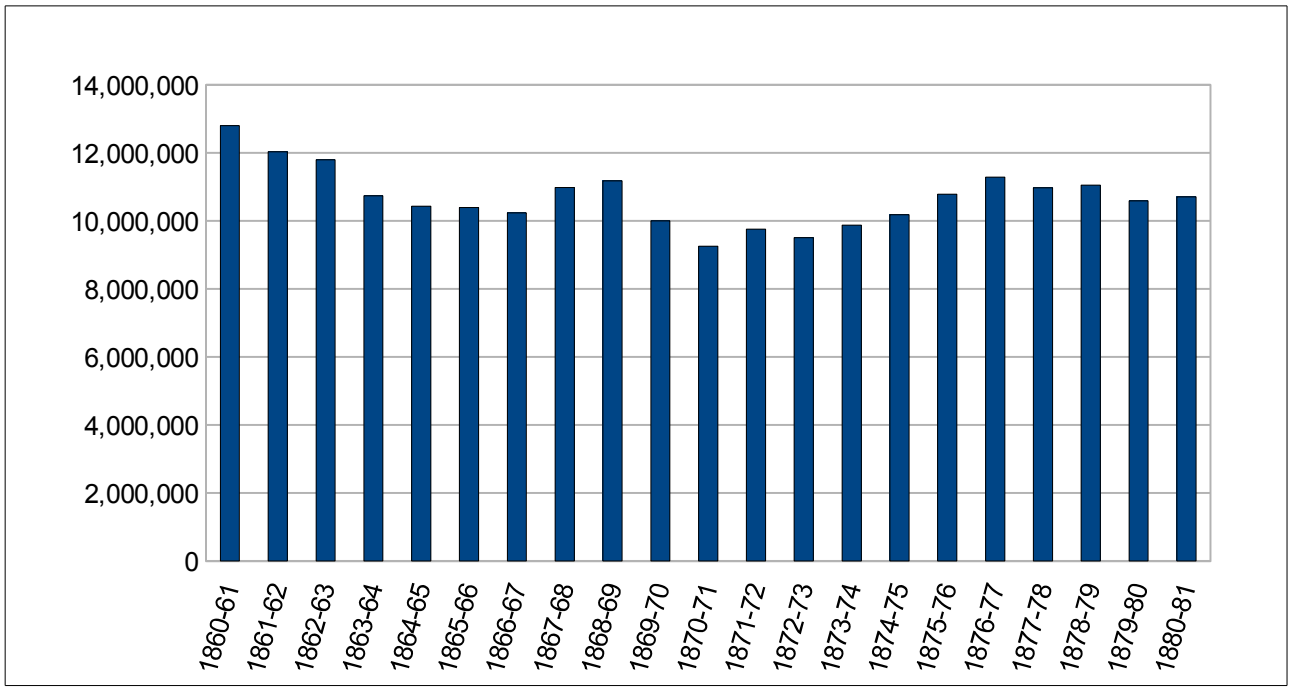
Despite its difficulties, Elswick was well equipped to enter successfully into foreign markets. First, it was in a position to offer a technologically advanced product which, moreover, had already been tested in war and whose performance reports were, in the majority of cases, enthusiastic. Second, the fact that Armstrong's guns had been deployed by the Royal Navy was a very good form of advertisement: what the most powerful Navy in the world used was worth considering. Third, competition was very limited. In Britain only Whitworth could manufacture guns of comparable quality; but it could not boast a plant as large and well equipped as Elswick which had now manufactured guns for more than six years. Abroad only Krupp was a potential competitor, but the German company had limited experience in making naval guns. Elswick, moreover, could rely on the contacts made selling cranes abroad and on the knowledge of foreign markets it had thereby developed. Finally, the profits from civil business could help keep the armaments business afloat in the short-term, while new customers were sought.

1.2 *British naval spending in an era of technological uncertainty, 1860-1880.*

British naval spending in the period 1860-1880 was more or less constant. Figure 1.5 shows the annual naval estimates voted by Parliament. In the late 1850s the naval scare caused by the laying down of *La Gloire* had pushed the British naval budget up. The trend, however, was rapidly reversed, and naval estimates were cut each year from 1860 to 1867, after which spending increased for two years. After such temporary and expansion, however, estimates declined again until the budget in 1870-71 fell to well below £10 million. In the first half of the 1870s naval spending grew again, although at a slow tempo, but declined in the second half of the decade so that in 1880-81 naval appropriations were lower than in the early 1860s.

[32] A copy of the letter is in *Correspondence Between Her Majesty Government and Sir William Armstrong*, HCPP (1863).

Figure 1.5: British naval spending, 1860-1880 (in current pound).



Source: *Naval Estimates* (HCPP), various years.

The key reason why British naval spending remained flat was that, notwithstanding that other countries laid down or ordered ironclads, Britain did not face any significant naval threat in this period. In the course of the 1860s France became more and more concerned with the rise of Prussia and it focus on strengthening its land forces.[33] In addition to this, France, because of its limitations in iron production, kept building vessels with composite hulls – that is made of iron and wood – for much longer than Britain. At the same time French artillery was regarded as generally inferior to its British counterpart.[34] The defeat in 1870 had an immediate impact on the French naval budget, which felt from three-quarters of the British budget in 1870, to half of it in 1872.[35] Naval construction restarted in 1873 when *Redoutable*, the first capital ship mainly built in steel, was laid down. Still, France did not pose a serious threat to British naval power well into the 1880s.

A country which pioneered ironclad design was the United States. During the Civil War, the Union built an impressive fleet which, at its peak, numbered 49 ironclads.[36] It was during this conflict that the first encounter between ironclads occurred, when USS *Monitor* and CSS *Virginia*

[33] L. Sondhaus, *Naval Warfare, 1815-1914* (London, 2001), 88-89.
[34] J. Campbell, 'Naval Armaments and Armour', R. Gardiner (ed.), *Steam, Steel and Shellfire: The Steam Warship 1815–1905* (London, 1992), 159.
[35] J. F. Beeler, *Naval Policy in the Gladstone–Disraeli Era, 1866–1880* (Stanford, 1997), 193 and 205.
[36] W. N. Still, 'The American Civil War', Gardiner (ed.), *Steam*, 61.

engaged in an inconclusive fight at the battle of Hampton Roads.[37] After the war, however, the fleet was starved of funds. By 1869 only 6 ironclads were still in service, all others having been either scrapped or sold to other countries. In the 1870s the size of the American fleet kept dwindling. The Russian and Italian fleets were too modest to pose a serious threat, although, as will be explained in the next chapter, some Italian battleships caused temporary alarm in Britain.

Furthermore, the Royal Navy spent the majority of the resources for new constructions in its own yards. Figure 1.6 shows data on British naval construction in the period 1860-1880, listing the total warship tonnage started each year, divided between Royal Dockyards and private shipbuilders. Nearly 60% of the tonnage started between 1860 and 1880 was built by the Royal Dockyard, and 40% by private firms. Counting only vessels with a displacement bigger than 5,000 tons, the percentages are slightly more in favour of the Royal Dockyards (63% versus 37%). One thing should be noted, however: when the transition to ironclads in the late 1850s and early 1860s occurred, the Royal Navy had to rapidly find a way to counteract French naval building. The Royal Dockyards, however, were not equipped to built iron-hulled vessels, only wooden warships. While the Dockyards were modernised, the Admiralty contracted the construction of its first ironclads to the private yards which had already had experience building iron hulls.[38] Therefore, a third of the entire tonnage built by private yards in the period 1860-1880 started in just three years: 1859-60, 1860-61 and 1861-62. In addition, for political reasons the Royal Navy sometimes purchased vessels which private yards were building for foreign countries. For example, in 1863 the British government seized two ships ordered by the Confederate government to avoid an infringement of the country's neutrality. In 1878 the ironclad *Independencia* for Brazil was purchased during the war scare caused by the Russian victories against the Ottoman Empire in the Balkans as part of a rapid reinforcement of the Royal Navy. Finally, the Admiralty always safeguarded its own yards: when construction budgets contracted, it was orders to private firms which were sacrificed. Moreover, it does not seem that the admiralty built strong connections with private firms. For instance, Napier, which had built several of the first ironclads, received few orders after the early 1860s. In general, even the private companies which received the most orders (such Palmer in Jarrow) were awarded no more than a handful of contracts. Therefore, despite the contribution of private yards being decisive in some periods (the early 1860s), in general, it was overshadowed by the activities of the Royal Dockyards.

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[37] W. C. Davis, *Duel Between the First Ironclads* (Doubleday, 1975).

[38] J. A. Hass, *A Management Odyssey: the Royal Dockyards, 1714-1914* (London, 1994), 103-105.

Figure 1.6: British naval construction, 1860-1880 (in tons).

Year	Tons built by Royal Dockyards	% built by Royal Dockyard	Tons built by private contractors	% Built by private contractors	Total tons ordered
1859-60	18,741	37.98	30,607	62.02	49,348
1860-61	10,710	44.38	13,420	55.62	24,130
1861-62	9,829	23.46	31,074	76.54	41,903
1862-63	0	0	3,687	100	3,687
1863-64	26,804	100	0	0	26,804
1864-65	3,122	25.35	9,192	74.65	12,314
1865-66	19,486	100	0	0	19,486
1866-67	18,425	70.35	7,767	29.65	26,192
1867-68	14,446	34.41	27,534	65.59	41,980
1868-69	18,054	42.8	24,126	57.2	42,180
1869-70	20,379	100	0	0	20,379
1870-71	26,185	65.29	13,920	34.71	40,105
1871-72	5,200	100	0	0	5,200
1872-73	15,467	74.34	5,340	25.66	20,807
1873-74	30,030	100	0	0	30,030
1874-75	8,180	25.75	23,583	74.25	31,763
1875-76	29,015	91.31	2,260	8.69	31,775
1876-77	10,770	42.99	14,280	57.01	25,050
1877-78	3,390	10.6	28,580	89.4	31,970
1878-79	17,830	100	0	0	17,830
1879-80	23,770	100	0	0	23,770
Total	329,833	58.2	235,370	41.8	566,703

Source: *Conway's All the World Fighting Ships, 1860-1905* (London, 1976), *passim*, S. Pollard and P. Robertson, *The British Shipbuilding Industry, 1870-1914* (Harvard, 1979), 217-219.

Until the 1880s, naval technology evolved mainly in two fields: ordnance and ship design. Artillery evolved along an incremental, path: the basic design of muzzle-loading rifled guns did not change, but the size of the largest pieces of ordnance increased markedly, making them more powerful. For instance, the wrought iron plates which protected the hull of *La Gloire* could

withstand at 200 yards shots from the smoothbore 68 pounder (with a calibre of 8.12 inches).[39] A few year later, however, the newly introduced 9 in. rifled guns could penetrate up to 12 inches of wrought iron plates with their projectiles weighting 250 pounds at a distance of up to 1000 yards. In the early 1880s 16.25 in. guns firing shells weighting 1800 pounds could penetrate 32 in. of armour at more then 1000 yards. To withstand the explosion generated by the larger amount of gunpowder required, guns shooting bigger shells required thicker barrels, thus driving up the weight. At the same time, this increase in weight represented a challenge for ordnance makers who had to design adequate mountings to move them into position. Figure 1.7 shows the calibre, weight and cost of some of the larger muzzle-loading guns used on British vessels

Figure 1.7: Data on the larger muzzle-loading guns mounted on British ironclads in the 1860s and 1880s

Year of design	Calibre (in.)	Weight (tons)	Price (pound)	Muzzle velocity (feet per second)	Maker
1866	12	25	1,715	1,300	Woolwich
1867	11	25		1,315	Woolwich
1871	12	35	2,154	1,300	Woolwich
1874	12.5	38		1,575	Woolwich
1874	16	80	10,000	1,590	Armstrong

Source: T. Brassey, *The British Navy: its Strength, Resources, and Administration*, vol. 2 (London, 1882), 38 and 95; *Treatise on the Construction and Manufacture of Ordnance in the British Service Prepared in the Royal Gun Factory* (London, 1879), 284; *Conway's All the World Fighting Ships, 1860-1905* (London, 1976), *passim*.

A clear trend is evident: guns increased in weight and cost more. In less than 10 years, between 1866 and 1874, there was an increase in weight of more than 50%, from 25 to 38 tons. The introduction of the 16 in. Armstrong guns represented a still more pronounced advancement, with a weight increase of more than 100%. In addition, the 80 ton gun cost four times more than the previous ones. The reason behind the escalation in size was that larger, more powerful artillery was

[39] From March 1863, the official nomenclature of British artillery changed: guns started to be defines by their calibre (in inches) instead by the weight of the shoots (in pounds).

required to pierce armour plates which were becoming thicker: while HMS *Warrior* was covered by 4.5 in. plates, by the end of the 1870s, ironclads boasted protection of up 18 in., an increase of 400% in twenty years. The deployment of thicker armour plates stimulated the production of larger guns which generated demand for stronger armour plates, and so on.

The field in which most changes occurred during the 1860s and 1870s was naval architecture. While this topic strictly speaking lies outside the scope of this thesis, it is important to stress the major developments which had an impact on armaments production. The introduction of ironclads made wooden sailing vessels obsolete overnight.[40] But ironclad design did not stabilise and many different designs were tried in the subsequent decades.[41] Part of this variety came from the fact that, until the 1880s, naval thinkers were still uncertain how a possible confrontation between ironclad fleets would unfold. The only significant naval battle which happened in this period – the battle of Lissa between the Italian and Austrian fleets in 1866 – seemed to point to the fact that ramming could still play a role in naval warfare (an Italian ironclad sank after been rammed). Guns, according to the supporters of the ram, were useful to immobilize and weaken the adversary, but it was the ram which had the task of finishing off enemy vessels. Design reflected these tactical uncertainties.[42]

Initially, broadside ironclads, such as HMS *Warrior*, were built. Guns were deployed along the two sides of the hull, as they had been for centuries in wooden sailing warships. This was a logical development based on the design of wooden steam vessels which had been built until then. The broadside vessels, however, faced a problem. Guns on board had a limited range of fire: they could only fire against enemies which were in front of them. An ironclad thus risked engaging an enemy vessel with only half its guns. This problem had been known for centuries, but it acquired new relevance because the growing dimensions and weight of the new rifled artillery (and of armour plates) meant that fewer guns could be placed on board. Thus, the fact that only a proportion of the new guns could be used represented a waste of potential destructive power.

To solve this problem two configurations were developed. The first, called the "central battery ship" or "casemate ship", had a heavily armoured structure amidships, the "citadel", where guns were placed, while the rest of the vessel was more lightly defended. Because all major

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[40] The transition did not happen overnight, though. The last wooden vessel of the Royal Navy, HMS *Rodney*, was retired from service in 1870: B. Lavery *The Ship of the Line – Volume 1: The Development of the Battlefleet 1650-1850* (London, 1983), 190.

[41] For the evolution of military naval architecture during this period: S. Tucker, 'The Period of Experimentation, 1865-90', id. (ed.) *Handbook of 19th Naval Warfare* (Stroud, 2000), 134-162.

[42] M. Allen, 'The Deployment of Untried Technology: British Naval Tactics in the Ironclad Era', *War in History* 15 (2008), 269-293.

components were concentrated at just one point, armour plate' thickness could be maximised in a limited place, and vessels could be built shorter and easier to handle. Central battery ships started to be introduced around the mid-1860s, supplanting broadside ironclads. The second design was called the "turret ship" because the main guns were placed in independent structures called turrets which could rotate, offering the maximum arc of fire for each gun. Despite some of the first ironclads having turrets, it took more than ten years to produce successful ocean-going turret vessels (the first British turret ironclad was HMS *Devastation*, laid down in 1869). Until then the fact that vessels were built with steam engines as well as sails complicated the possibility of deploying turrets because masts limited their arc of fire. The introduction of more efficient compound engines allowed navies to dispense with masts and use turrets more effectively.[43] These different designs emphasize the importance of few but very large guns. While the first ironclads were armed with tens of guns (HMS *Warrior* had forty), later vessels seldom had more than 4 or 6 major guns, plus a few small calibre pieces.

1.3 *The rise of Armstrong, 1863-1882*.

This section examines the evolution of the newly created Sir William G. Armstrong Company from 1863 until 1882, when Armstrong merged with Mitchell, a shipbuilding concern. The sources used should first be noted, however. From 1864 to 1882 the Sir William G. Armstrong Company was a partnership. For a partnership, legal obligations in terms of book keeping and balance sheets publicity were limited. This makes a systematic analysis of the company and of its activities problematic.[44] Letters exchanged between the partners, newspaper articles and personal memoirs need to be used to supplement the limited official records available. The relationship between Armstrong and Italy, one of the firm's major customers, is analysed in the next chapter.

In 1864 the newly established company faced difficult circumstances: the gun making business, which had grown rapidly in the previous 4-5 years, had lost its only customer. In order to survive, the gun factory needed to find new customers quickly. Three events helped Armstrong achieve this objective. The first was the structural shift in naval design. The introduction of

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[43] D. Griffiths, 'Warship Machinery', Gardiner (ed.), *Steam*, 174-175.

[44] It is testimony of this that Kenneth Warren devotes less than four pages to the period 1864-1882 in his book on the history of Armstrong.

ironclads inaugurated a new era in naval construction. Governments all over the world were now scrambling to replace their wooden vessels with modern ironclads. Old smoothbore guns were ineffective against the newly protected vessels. As a consequence, ironclads generated a demand for artillery which could smash iron plates. Armstrong thus had the chance to obtain orders for guns which could do that. In addition, the introduction of rifled artillery was not a "one-off" innovation, but naval ordnance technology kept evolving rapidly in a way which had never happened before, generating additional demand for armaments by countries which wanted to keep up with further improvements. Moreover, the fact that the Royal Navy deployed guns built using the "Armstrong method", if not directly manufactured by Armstrong, was good publicity which helped Armstrong to become a household name in naval circles.

The second factor was that Armstrong's entry into this market coincided with a period of intense military confrontations: the American Civil War from 1861 to 1865, the German-Danish war in 1864, the Austro-Prussian War and the Third Italian Independence War in 1866, the War of the Triple Alliance in South America from 1864 to 1870, and the Franco-Prussian War in 1870. While Armstrong, as will be shown below, sold armaments to some of the governments involved in these confrontations, these military encounters had another indirect beneficial effect: they increased all governments' awareness about the need to deploy modern armaments, hence increasing the appeal of Armstrong's products.

The third favourable circumstance was that the firm faced very limited competition during its first twenty years of operations, something which changed significantly in the following decades. In 1863, only a few companies in Europe were geared up to manufacture large guns: the two British rivals, Whitworth and Armstrong, and Krupp, in Germany. All of these companies had large and successful civil engineering departments which helped the companies to weather the ups and downs of military demands. Their relative position, however, was not equal. Whitworth could claim to be the first British gun maker to sell modern artillery abroad: in 1862 he received a small order for guns from Brazil.[45] Whitworth's armaments business, however, never took off. After Armstrong's guns won the competition for the new rifled ordnance, Whitworth continued to pursue his studies of artillery. His efforts to find a way to increase the strength of steel barrels resulted in an important discovery: a way to produce high quality ductile steel through the application of high pressure to the metal when it is on fluid state.[46]

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[45] G. A. Gratz, 'The Brazilian Imperial Navy Ironclads, 1865–1874', A. Preston (ed.), *Warship 1999–2000* (London, 1999), 140-162.

[46] Whitworth published a description of his artillery system and of his innovations in steel production, J. Whitworth,

However, the business side of Whitworth's ordnance business was much less successful: few Whitworth guns were sold.[47] A combination of elements explains the different trajectories of Armstrong and Whitworth. First, Whitworth's personality: he was a talented engineer, but "the unfortunate treatment to which he was subjected was due in part, no doubt, to his plain and inflexible determination. Whitworth always refused to modify a model which he knew to be right out of deference to committees whom he regarded as incomparably his inferiors in technical knowledge. Whitworth appears to have become increasingly irascible and domineering as he grew older."[48] In other words, Whitworth lacked the flexibility which Armstrong displayed when he decided to stop producing breech-loading guns when they proved unsatisfactory; and he was not able, as Armstrong did, to build up a successful team of collaborators and partners.

A second fact was that Armstrong had a much deeper experience of *actually* making guns. He had supervised production in Woolwich when he was superintendent there for a few years. Whitworth, on the other hand, had limited experience of large scale gun manufacturing. In addition Armstrong could count on a fully equipped plant – and a trained workforce – which had produced guns and mountings for years. Armstrong, thus, did not face the problem of having to fund large new plants and equipment to start producing. The fact that he could start making guns overnight certainly helped him to secure the first customers.

A last factor was that Armstrong's successful beginning – explained by the fact that he could rely on a working plant, personal experience, good collaborators, etc. – made it ever more difficult for Whitworth to secure large orders – irrespectively of the quality of his products. Every sale made by Elswick provided additional publicity for Armstrong's guns and it enlarged the network of contacts the firm could rely on, and, above all, locked in the client to Armstrong's technology. After a navy adopted guns from a certain producer, it became more complex for it to shift its artillery to the design of another producer (the case of Italy, examined in the next chapter, provide a clear example of this "technological path dependency").

Whilst Armstrong's and Whitworth's interest in artillery dated only from the years of the Crimean War, Krupp had a much longer expertise in manufacturing armaments: the first member of the Krupp family associated with the armaments trade was Anton Krupp in the 17th century, at the time of the Thirty Years War.[49] During the first half of the 19th century, however, the results of

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Miscellanious Papers on Mechanical Subjects. Guns and Steel (London, 1873).

47 Also the laudatory profile of Whitworth in W. T. Jeans, *The Creators of the Age of Steel* (New York, 1884), 213-268, does not mention any order for guns other than that coming from Brazil.

48 T. Seccombe, 'Whitworth, Joseph', *ODNB*.

49 W. Manchester, *The Arms of Krupp* (Boston, 1968), 43.

Krupp's involvement in armaments trade were mixed. Alfred Krupp, who was at the helm of the business for sixty years and the driving force behind the company's venture in ordnance manufacturing, regarded cast steel as the most suitable material for gun manufacturing.[50] He started experimenting with it during the 1840s and submitted a 6 pounder prototype for the 1851 Great Exhibition. But Krupp's view about the advantages of steel guns was not shared by the Prussian military hierarchy. The explosions of several of Krupp's cast steel guns reinforced their suspicion. Eventually Krupp's guns were adopted by the Prussian army in the late 1860s. Ultimately, the superior performance of German artillery during the 1870 war with France, whose army was still equipped with old fashioned muzzle-loading bronze guns, dispelled the last suspicions and provided Krupp with a publicity coup.[51] However, land armaments, rather than naval ordnance, represented the main market for Krupp, with Russia and the Ottoman empire as its major customers.[52] The small size and limited budget of the German navy provided little incentive for Krupp to focus on this kind of production.[53]

Armstrong was well aware of the potential threat represented by Krupp. In August 1863, *The Times* reported that the upper echelons of the British military, during a visit to the Royal Arsenal, had inspected several cast steel Krupp guns which "had been submitted for trial and fired successfully".[54] In December 1863, Armstrong wrote joyfully to Rendel that a Krupp steel gun had exploded "and that too with a vengeance, flying into a thousands pieces. All the fragments were sound so that the failure was purely due to the intrinsic unfitness of the material. I have had this nice piece of news conveyed to Lord de Grey [the Under Secretary for War]."[55] What Armstrong feared was not that Britain would start to buy from Krupp (the British government was not buying from Armstrong any more), but that it would endorse the idea of cast steel guns. Armstrong's reputation rested on Armstrong's building system which used wrought iron coils. Hence, if another manufacturing process came to be preferred, this would represent a significant blow for the fledgling firm.

Thus, in this period, Armstrong faced more competition from government-owned arsenals than from other private companies. Governmental arsenals were not geared to manufacture for

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50 R. Köhne-Lindenlaub, 'Krupp, Alfred', *NDB*.
51 Manchester, *Krupp*, 141 and 156.
52 On Krupp's export of artillery, J. A. Grant, 'The Arms Trade in Eastern Europe, 1870-1914', D. J. Stoker Jr. and J. A. Grant (eds.) *Girding for Battle: the Arms Trade in Global Perspective, 1815-1940* (Westport, 2003), 30-34.
53 Until the late 1870s, the majority of the guns of the Prussian Navy came from the Royal Foundry in Spandau: L. Sondhaus, *Preparing for Weltpolitik: German Sea Power before the Tirpiz Era* (Annapolis, 1997), 73.
54 *The Times* 3 August 1863, 9.
55 J. D. Scott, *Vickers. A History* (London, 1962), 32.

export, but the size and quality of their output had a direct impact on the demand for guns from private suppliers. In general, tradition-minded military hierarchies remained cold towards the idea of relying for armaments manufacturing on private enterprises. Until 1914, public arsenals and dockyards remained deeply involved in armaments manufacturing despite their relative decline. In a market which started to be characterised by endless technological, innovation, however, Armstrong's ability to innovate rapidly meant that the company was able to gain a large share of the world market for naval ordnance and mountings.

The ability to design gun mountings became crucial after the introduction of heavier guns. Armstrong's position in this area was especially strong, because of its expertise in gun mountings. For instance, in a letter dated 15 March 1878 sent to the French Ministry of marine, the company's management complained that the French navy had only ordered the hydraulic mountings and not also the guns for them. What is more, Elswick deplored the fact that the French navy had ordered "high pressure pumping engines" from other companies, and that it planned to use them in combination with its mountings. Armstrong pointed that the less than perfect compatibility between these pieces and its mountings could hinder the performance of the latter, and therefore suggested that the French minister should purchase them directly from it, in order to "allow a satisfactory performance of the carriages".[56] Both Armstrong and its customers were well aware of where the firm's technological superiority lay.

It is not surprising that, in the period from the 1860s to the early 1880s, Armstrong's major clients were small and medium powers, countries which desired to modernise their naval forces, but which could not rely on arsenals for the manufacture of up-to-date equipment, as Britain did. By contrast, during the first fifteen years of Armstrong's activity British orders were worth in average just £1,654 per year.[57] While the precise number is disputable, the order of magnitude cannot: British government's orders represented a very small share of the firm's total sales. Figure 1.8 shows the main orders the company received during its first five years of activity.

These figures highlight how many governments were Armstrong's customers even in the first years of its activities. Divisions among the various buyers is immediately clear, though. Three different groups can be identified. The first was made up of buyers such as Italy, Spain and the Ottoman Empire, which placed large orders. These countries had regional political and military ambitions and thus they needed to rapidly modernise their armed forces, equipping them with hard-

[56] T&W, *Rendel Papers*, 31/4622.
[57] Scott, *Vickers*, 34.

Figure 1.8: Armstrong major armaments sales, 1864-1867.

Country	Year	Amount order
Denmark	1864	Several 150-pound guns
USA	1864	£ 5,000*
Turkey	1864	£ 150,000 in guns and ammunitions
France	1864	A few experimental guns
Egypt	1864	More than £ 4,000
Italy	1865-66	£ 100,000 worth of guns
Austria	1866	Guns for five ironclads (£ 30,000-50,000)
Spain	1867	£ 65,000
Norway	1867	Guns and ammunitions
Holland	1867	Guns and ammunitions
Russia	1867	One 300-pound gun

* eventually, only half of the agreed sum was paid.

Source: T&W *Rendel Papers*, 31/3375-3561.

ware that their own arsenals could not supply. Their only alternative was to turn to private suppliers. These buyers remained good clients of Armstrong for decades. Moreover, it is noteworthy that Armstrong ended up being involved, although in different ways, in the management of production facilities in all of these states.

The second group was composed of small states like Holland and Norway which had modest military needs and, in some case, limited financial means. Orders coming from these countries were sporadic and small in size. While governments belonging to the first group kept ordering new hardware to avoid technical obsolescence, the ones of the second group did not.

Finally, great powers such as France and Russia constituted the third group. For strategic and political reasons these countries clearly could not rely on British companies for their own armaments in any significant way. This would have meant becoming dependent on the good will of the British government which could stop exports at any time. This was obviously unthinkable for governments which, until the beginning of the 20th century, saw Britain as their main strategic competitor. At the same time these countries had large, if not always efficient, public arsenals which supplied the bulk of their artillery. The reason why they bought Armstrong's products was that they aimed to gain a first-hand knowledge of the more advanced technologies and designs of the firm's

products. To do this, they just needed to buy a limited number of guns.

At the same time as the British government ended its contract, the American Civil War seemed to promise sale opportunities to Armstrong. The British government had forbidden national companies to supply belligerents;[58] but Armstrong and Whitworth were both able to provide guns to the Union and the Confederation, using legal loopholes and sales to third parties.[59] This first venture proved, however, to be a source of much disappointment for the newly established company. Armstrong had originally been approached by John Scott Russell, a brilliant naval engineer who was working in Britain as Union agent commissioned to purchase military goods.[60] Russell hinted that Massachusetts wanted to purchase several large calibre guns for the protection of Boston's harbour. Soon, however, controversy erupted: Russell had apparently embezzled the money and Elswick resorted to legal action to recover what was due for the guns. Eventually, the company obtained compensation of £2,500, half of the original price.[61] This experience taught Armstrong a lesson: from that time on, the company became more cautious in dealing with agents acting on behalf of foreign governments. The company preferred developing its own network of representatives and agents around the world, trusted people whose personal connections, technical knowledge, and experience could secure orders.

Stuart Rendel was at the helm of the commercial operation of Elswick until 1880, when he was elected MP for Montgomeryshire.[62] He was the son of the late James Rendel, Armstrong's friend who had interested him in ordnance. When James died in 1856, his eldest son, Alexander, inherited the family's engineering business.[63] All his brothers ended up working for Armstrong. The third son, George Rendel, worked as an apprentice at Armstrong's crane firm, before becoming a partner in the Elswick Ordnance Works in 1859. Five years later he was among the founders of the Sir William Armstrong Company, where he was in charge, together with Andrew Noble, of the ordnance business. George involved himself in two main activities. The first was the design of ordnance and mountings. He improved the hydraulic system used to move guns which was later

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58 As a result of a1861 Cabinet Order in Council.

59 *The Times* reported that "Armstrong's guns had been sold to the Confederates", but the company denied this allegation, see *The Times*, 21 January 1864, 9. More than fifty years later, however, Stuart Rendel stated that the firm supplied both sides and that he was unable to remember what side placed its order first, see Rendel, *Papers*, 277-278. Armstrong was not the only firm involved: for instance, in October 1863 the British government seized two vessels which Laird of Birkenhead was building for the Confederate Navy, W. F. Spencer, *The Confederate Navy in Europe* (Tuscaloosa, 1983), 111.

60 D. K. Brown, 'Russell, John Scott', *ODNB*.

61 T&W 31/204.

62 J. Grigg, 'Rendel, Stuart', *ODNB*.

63 The company is still active in engineering consultancy nowadays under the name of High-Point Rendel Ltd.

universally adopted on British battleships in the 1880s and 1890s. George was also interested in naval engineering: he designed many of the first warships built by Armstrong. At the same time, he was often consulted by the Admiralty, and in 1882 left the firm to become a civil lord of the Admiralty, a technical advisory post. In 1885 he moved to Italy where, as will be explained in chapter V, he became involved in supervising the activities of Armstrong's local branch.[64] Finally, Hamilton, the youngest brother, managed the civil engineering business of the company for five decades. His most famous achievement was designing the hydraulic machinery used to move the bascules of London's Tower Bridge.[65]

Stuart Rendel did not purse an engineer career like his brothers, but became a barrister. He was first employed by Armstrong in the late 1850s when he became a member of the Special Committees which were created in the early 1860s to investigate the benefits of new artillery designs.[66] His brief was to defend Armstrong's reputation from the attacks of Whitworth's supporters. After Armstrong left Woolwich, Stuart became the chief commercial representative of Elswick in London, receiving a commission of 5% on the orders he acquired.[67] In addition, in the course of the decade Armstrong sold him for £19,600 a 4% interest in Elswick, a price which valued the entire firm at £490,000. The Armstrong Company did not develop a sales office, a structure separated from the rest of the company, with a staff trained in sales techniques; but examining the letters exchanged among themselves by the people at the top of the firm, it is possible to detect a division of tasks between them. The management in Elswick was chiefly involved in designing, improving and manufacturing the products. The London office under Stuart Rendel was in charge of sales and promotion. London was the key diplomatic hub in the pre-1914 period, where scores of foreign ambassadors and military attaches regularly met. Many of them routinely visited the Royal Arsenal, and attended armament trials and ship launching.[68]

The first challenge Armstrong faced was that of monitoring foreign markets in order to be well placed to exploit any possible sales opportunity. When Armstrong entered the world market for armaments, telegraphic cables were just starting to be rolled across the seas and the technology was not yet completely reliable.[69] This meant that while European markets could be quite easily

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64 M. R. Lane, 'Rendel, George Wightwick', *ODNB*.

65 M. R. Lane, *The Rendel Connection: a Dynasty of Engineers* (London, 1989) traces the history of the family business.

66 See for instance, *The Times*, 4 November 1864, 7.

67 T&W, *Rendel Papers*, 31/3433.

68 See among the many cases, the articles appeared on *The Times* 25 January 1858, 10, about the visit of Albert, Prince of Prussia, to the Royal Arsenal, and 21 June 1873, 9, about the tour of the same facility offered to the Shah of Persia.

69 The first successfully operating oceanic cable was installed in 1866.

monitored from London, this was not the case for Asia and South America. Thus the company had to employ agents in these overseas regions. Selling armaments, however, was no ordinary business. The peculiar nature of the armaments trade made traditional sales techniques less useful. It was after governments had decided to purchase new artillery that armaments companies could start courting generals, ministers and bureaucrats in the hope of obtaining orders, but not before.[70] Hence the main task of agents was twofold. On the one side they had to promote their products. Technical brochures, pictures and invitation to live trials were all means used to advertise the superior performance of Armstrong's artillery.[71] On the other side, they collected intelligence and information about military plans and possible tenders, and then forwarded them to the company's headquarters. Subsequently, when a government had committed itself to a rearmament plan, it was the agents' ability to navigate civil and military bureaucracy which became crucial in securing contracts. Agents needed to have some understanding of both military technology and commercial practice, as well as a good knowledge of the country where they operated. Few possessed this combination of skills and knowledge, and so it is not surprising than many of the offers to become agents were turned down by Armstrong.[72]

The company records for China offer interesting material for an analysis of the possibilities and limits of this model. China represented a potential market for Armstrong. After the end of the Taiping rebellion in 1864, a groups of politicians in favour of "self-strengthening" policies gained power in Beijing. One of their aims was to reinforce the country vis-a-vis foreign powers through the modernization of Chinese armed forces and the development of indigenous armaments industries.[73] One of the first steps was ordering eleven flat-iron *Stauch*-class gunboats in Britain (see Figure 1.9).[74] Armstrong manufactured their guns, while the hulls were built by the Walker shipyard on the Tyne and one by the Laird yard in Birkenhead.[75] Sir Robert Hart, the General Inspector of the Chinese Imperial Maritime Customs Service, worked to facilitate the purchase, which was made possible by the revenues collected by the Service on behalf of the Chinese

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70 On the demand-driven nature of armaments trade see C. Trebilcock, 'Legends of the British Armament Industry 1890-1914: A Revision', *Journal of Contemporary History* 5 (1970), 3-19.

71 Materials of this nature can be found in the archives of all the armaments companies.

72 See, for instance, T&W, *Rendel Papers*, 31/3437, 31/2787, 31/6155 and 31/3260.

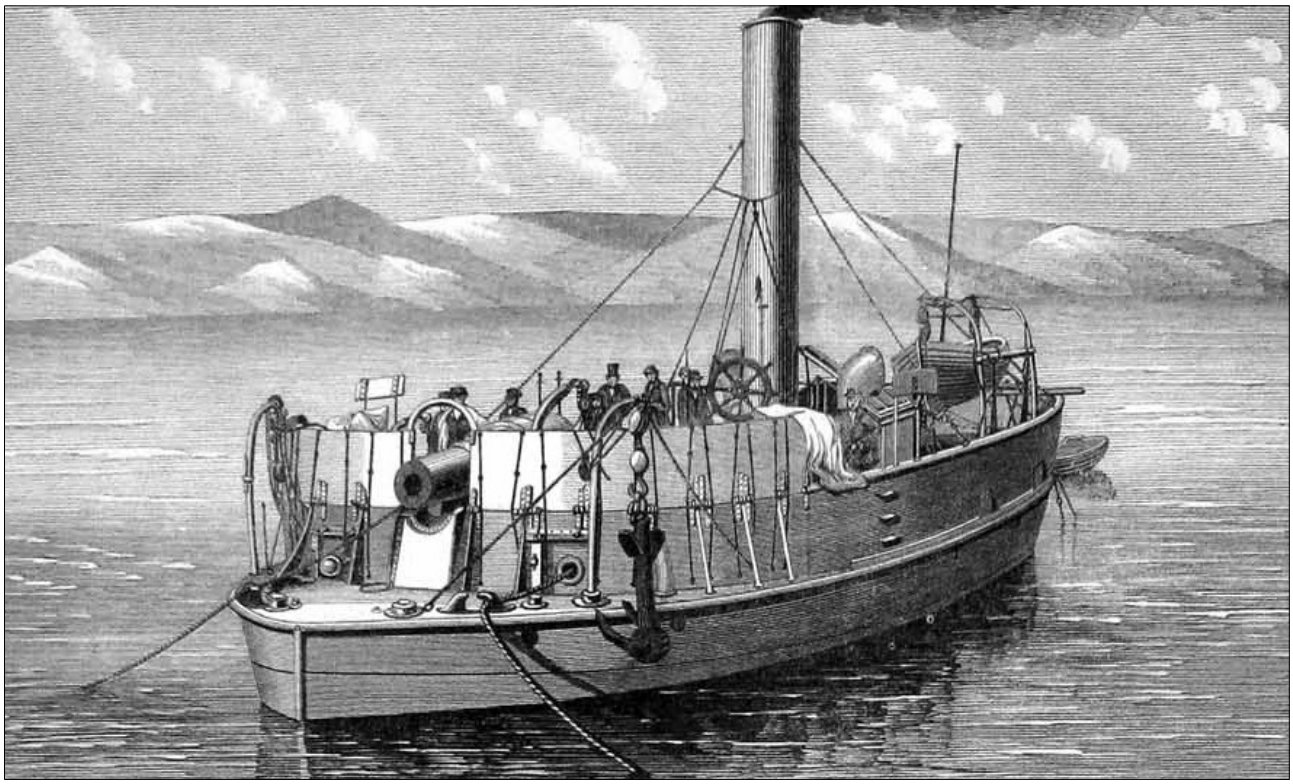
73 For the military aspects of the "self-strengthening" movement see Kwang-Ching Liu and R. J. Smith, 'The Military Challenge: the North-west and the Coast', J. K. Fairbank, Kwang-Ching Liu, D. Cr. Twitchett (eds.) *The Cambridge History of China*, vol. 9, *Late Ching 1800-1911*, Part 2, (Cambridge, 1980), 202-272.

74 J. L. Rawlinson, *China's Struggle for Naval Development, 1839-1895* (Cambridge, 1967), 69.

75 P. Brook, *Warships for Export: Armstrong Warships 1867-1927* (Gravesend, 1999), and R. Wright, *The Chinese Steam Navy, 1862–1945* (London, 2001) offer detailed descriptions of these vessels.

government.[76] This was a promising beginning (each gunboat cost between £23,000 and £33,400, the whole sale totalling more than £250,000, but it was not followed by other significant orders.[77] The company's agent in China from the early 1880s onwards was Jardine & Matheson, the renowned trading firm.[78] Jardine had an excellent grasp of the Chinese market, a sophisticated network of contacts and plenty of commercial capabilities.[79] Although Elswick kept receiving long reports detailing the activities carried out on behalf of the firm, orders did not materialize.[80] After the 1884 war with France, the Chinese leadership turned to Germany, which had limited colonial interest in China, in contrast to Britain, to modernise its navy. It ordered two 7,000 tons battleships from the AG Vulcan Shipyard in Stettin and their guns from Krupp.[81]

Figure 1.9: Gunboat *Staunch*. The size of the gun is highlighted by the limited displacement.



Source: *The Engineer*, 1 May 1868, 321.

76 F. H. H. King, 'Hart, Sir Robert', *ODNB*.
77 Only other two small vessels were ordered in 1885, T&W, *Rendel Papers*, 31/2650.
78 Id., 31/3120.
79 See C. M. Connell, 'Jardine Matheson & Company: The Role of External Organization in a Nineteenth Century Trading Firm', *Enterprise and Society* 3 (2003), 99-138.
80 T&W, *Rendel Papers*, 31/2974, 31/4667, 31/4192, 31/5277. For a detailed overview of the activities of several of Armstrong's representatives in Asia, Bastable, *Arms*, 146-154.
81 Chia-Chien Wang, 'Li Hung-chang and the Peiyang Navy', *Chinese Studies in History* 25 (1991), 52–66.

A major development which occurred in these years was the connection which Armstrong developed from 1867 with Charles Mitchell's shipyard in Low Walker, a suburb several miles east of Newcastle. During the early 1860s Charles Mitchell worked in Russia for the Tsarist government where he designed and supervised the construction of four ironclads, the first to enter service for the Russian Navy.[82] As pointed to by David Saunders, it was exactly the experience in military shipbuilding which Mitchell had acquired which convinced Armstrong to pair up with him. In the years 1868-1885, before a new yard was opened in Elswick near the ordnance plant, 29 warships totalling 25,013 tons were built at Low Walker, the great majority of which were *Staunch* gunboats.[83] The contribution of Armstrong was decisive: these warships were in fact designed by George Rendel around the powerful guns which Armstrong supplied. The collaboration between the two firms, which was limited to naval shipbuilding, was a first step in the direction of vertical integration which Armstrong completed only in 1897. The appeal of the *Staunch* gunboat was the combination between a powerful gun, similar in calibre to the ones deployed on the large ironclads, and a shallow draft (they were less than 30 meters long, with a displacement between 200 and 500 tons) which allowed them to be used in coastal waters. These ships could not venture into open seas, but they were cheap and very powerfully armed, making them perfect for small or poor countries. Apart from the ones bought by China, the Royal Navy acquired three gunboats, and the Dutch navy two. In the late 1870s George Rendel designed also three small cruisers: one for Chile, which sold it to Japan; and two for China. These vessels anticipated the deeper involvement of Armstrong in naval shipbuilding which came after the 1882 combination with Mitchell.

In the years 1864-1882, Armstrong grew from being a firm with no market, to one supplying governments around the world with guns, mountings and warships. The limited sources prevent investigation of many aspect of the firm's development, but it is evident that Armstrong was a profitable venture. The crucial fact was that Armstrong in this period relied chiefly on export. Britain could count on its arsenals, but scores of small and medium governments could not, and, therefore, eagerly purchased from Elswick the military hardware they needed.

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[82] On Michell's Russian activities D. Saunders, ‘Charles Mitchell, Tyneside and Russia's First Ironclads’, in Northern *History* 48 (2011), 75-95.

[83] Brook, *Warships*, 11.

1.4 *Sheffield armour makers, 1860-1880.*

This section deals with the activities of the two Sheffield firms John Brown and Cammell which emerged from the early 1860s as the major maker of armour plates in Britain. The evolution of these two firms followed similar patterns of growth and thus they can be analysed together. John Brown and Cammell were established in Sheffield in the late 1830s as small family firms manufacturing steel products.[84] Like the entire steel industry of Sheffield, the impetus behind their initial growth came first from crucible steel, which was used for tools and cutlery, and later from the railway industry. John Brown and Cammell were the first firms to adopt the Bessemer steel process for purely commercial reasons in, respectively, 1860 and 1861.[85] While crucibles produced steel of very high quality, it was the Bessemer converter which allowed to rapidly escalate output, revolutionising the entire Sheffield steel industry.[86] The combination of an early start with a booming demand for steel rails, allowed John Brown and Cammell to grow fast. Whereas in 1857 John Brown employed around 200 men, in 1867 it employed nearly 4,000.[87] Cammell followed a very similar pattern of growth and by mid-1860s employed almost the same number of workers.

The first Sheffield firm involved in the armaments industry was Thomas Firth & Sons which in the late 1850s supplied Elswick, Whitworth and the Royal Arsenal with steel forgings for guns.[88] But it was the introduction of ironclads which opened up a potentially very large market for wrought iron armour plates. Attracted by this possibility, several firms attempted to enter armour production by submitting prototypes for trial.[89] John Brown initiated armour plate production in 1858 and, by 1862, it was a well-established producer. John Brown's success rested on technological superiority. In 1863 the Admiralty organised a trial at Portsmouth between an armour plate supplied by John Brown and one produced by the Royal Dockyards (the only attempt made by any government plant to produce it). The plate made by the Royal Dockyard was obtained by hammering and welding together iron sheets to form a plate of the required shape and thickness. By contrast, John Brown adopted a more complex production process, made possible by the industrial and technical capacity it had developed in the previous years in its modern plant. It rolled a

84 G. Tweedale, 'Brown, John', *ODNB*, and id. 'Cammell, Charles', *ODNB*.

85 The first firm to use the Bessemer process was the Bessemer Steel Works in Sheffield founded by Henry Bessemer himself. Bessemer's aim, however, was "not to work my process as a monopoly, but simply to force the trade to adopt it by underselling them in their own market.", H. Bessemer, *An Autobiography* (London, 1905), 175-176.

86 G. Tweedale, *Steel City. Entrepreneurship, Strategy, and Technology in Sheffield 1743-1993* (Oxford, 1995), 61-70.

87 A. Grant, *Steel and Ships: the History of John Brown's* (London, 1950), 21.

88 P. J. Nunn, 'Firth, Mark', *ODNB*.

89 In 1864 the Admiralty tested plates made by Cammell, John Brown, Mersey Steel and Iron company, Milwall Iron Works and Beale and Company, see *The Times* 19 February 1864, 12.

succession of 1 in. thick bars, cut them into short lengths, then piled and welded them into slabs which were rolled to make armour plates. The trial demonstrated the clear superiority of John Brown's plate.[90]

The technical advantage secured John Brown consistent orders. To keep up with the demand, the firm built a new rolling mill specifically designed for armour plates at a cost of £200,000.[91] Aware of John Brown's success, Cammell entered into armour production the same year. Cammell hired technicians and skilled workers from firms which had already tried to make armour plates and, after several experiments, obtained plates which satisfied the Admiralty's requirements and in 1864 Cammell received the order for the armour plates of HMS *Royal Alfred* and HMS *Lord Clyde*, establishing itself as the other major British producer.[92] Cammell and John Brown's technological leadership was confirmed in a trial of plates submitted by private firms occurring in 1864: their plates were the only ones which received the highest mark.[93]

Cammell and John Brown were then able to supplement their civilian operations with production of war-like stores. They entered armour plates production because of both demand-led and supply-led reasons. When the Admiralty committed itself to ironclads, it immediately generated a large and relatively stable demand for armour plates. Ruling out production carried out by government arsenals (this does not seems to have been an option seriously considered), the government could only rely on private firms. At the same time, government contracts were attractive as a hedge against the ups and downs of the market for civil goods (the early 1860s, for example, were a period of great uncertainties because of the American civil war).

The success of John Brown and Cammell was rooted in a mix of factors. Technological capacity was certainly paramount: their wrought iron plates scored very successfully in trials. Another factor was that their management teams, under, respectively, the leadership of John Devonshire Ellis and George Wilson,[94] were willing to invest large sums for the machinery required for large scale armour production. This was certainly facilitated by the fact that, already before entering armour making, John Brown and Cammell were the largest steel firms in Sheffield. In 1864, for instance, Cammell employed around 3,500 workers, and John Brown 3,300, while

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90 A. D. Stacey, *A Historical Survey of the Manufacture of Naval Armour by Vickers Sons & Co., and their Successors 1888-1956*, VA, f. 1153, 12.

91 Grant, *Steel*, 21.

92 VA, f. 401.

93 The scores were reported on *The Times* 10 March 1864, 14: John Brown obtained 3 A1 and one A2 for a curved plates (the highest score ever obtained for this kind of armour until then), Cammell one A1, Mersey one A3 "inferior", Millwall one A3, and Beale one B1.

94 G. Tweedale, 'Ellis, John Devonshire', *ODNB*.

Vickers, whose activities were limited to non-military productions, despite being the single largest producer of crucible steel in Sheffield, employed only around 1,000 workers.[95] Given their size, John Brown and Cammell felt less the financial and organisational strains of undertaking the investments required, they could afford to spend time and money to refine and improve plates and preserve their technical leadership. In 1864 both firms took advantage of the 1862 Company Act to restructure themselves as public limited companies and raise additional capital. Cammell issued capital for £800,000 and John Brown for £750,000. As a comparison, in the same year Vickers issued capital for £155,000.[96]

Furthermore, the fact that both firms were located in the same place facilitated the circulation of informal knowledge and technical know-how relevant for armour plate production, increasing the firms' capacity to innovate. A final advantage resulted from being "first movers" in armour production, a dynamic which replicated itself several times in the capital-intensive armaments industry (for example, the case of Armstrong highlighted above). Armour making was costly, therefore any new entrant required large investments. The price tag for an armour plate plant was estimated to be at least £250,000.[97] Such large investments could be undertaken only if there was a realistic chance of obtaining orders big enough to cover the large fix costs, something which was unlikely to happen when naval expenditures were flat or growing only at a modest rate. At the same time, the Admiralty, while being theoretically in favour of enlarging the number of suppliers for economic (driving down prices) and strategic reasons (the more firms making armour, the easier it was to escalate production in case of conflict) had to take into consideration the quality of the final products. Subsequent technical innovations exacerbated this fact, reinforcing the dominant position that Cammell and John Brown had acquired in the course of the 1860s and which they retained unchallenged until the early 1890s. It was not by chance that the firms which subsequently successfully entered armour production were already large (to finance the investments required), with a good reputation for quality (reducing the level of uncertainty for customers) and that they did so at a time of growing naval budgets.

While the focus here is on military production it must be stressed that John Brown and Cammell remained steel firms with a foot in armour making, and that military goods did not displace civil production as the major business. For instance, figure 1.10 shows John Brown's armour plate sales and general turnover in the period 1865-1874.

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95 Id., *Steel City*, 65.
96 Id.
97 *Iron and Coal Trade Review* 8 June 1883, 665.

Figure 1.10: Turnover of John Brown, 1865-1874 (in current pound).

	1865	**1866**	**1867**	**1868**	**1869**
Total turnover	404,072	511,215	584,081	585,716	663,279
Armour plate	223,498	119,178	95,064	148,175	110,950
Total	627,570	630,393	679,155	733,891	773,229
% of Armour plate on total turnover	55.31	23.31	16.28	25.3	16.73
	1870	**1871**	**1872**	**1873**	**1874**
Total turnover	751,719	797,358	1,159,999	1,353,021	1,055,011
Armour plate	177,436	152,721	251,691	212,513	211,245
Total	929,155	950,079	1,411,690	1,565,534	1,266,256
% of Armour plate on total turnover	23.6	19.15	21.7	15.71	20.02

Source: Calculation based on data from Tweedale, *Steel City*, 74.

Armour-making generated on average between 15% and 25% of the firm's total turnover. What actually increased substantially in the period 1865-1874 was the total turnover of John Brown, rather than the proportion contributed by armour plate production.

Until the introduction of compound armour in 1879-1880, armour plate technology did not change significantly, but the Admiralty ordered thicker and thicker plates to counterbalance the growing power of artillery. Then John Brown and Cammell needed to invest continually to deliver plates of the thickness required.[98] Armour plate was a profitable business, and it was essential to preserve the leading position of the firm in it. As the board of Cammell concluded in 1868:

> In this country [John Brown] and ourselves are the only two houses now in the books of the Admiralty and War Office … it is of vital importance we preserve this position in order to maintain the good prices we are now getting … To do this there is no alternative, but to meet the demands made upon us by adopting the means of finishing our armour as we are able to roll it, and then keep faith with

[98] K. Warren, *Steel, Ships and Men: Cammell Laird, 1824-1993* (Liverpool, 1998), 44-46.

> our deliveries, for unless this be done, the Admiralty will, we are assured, immediately proceed to encourage others to re-enter this trade and thus create anew a competition as will again result in loss and almost unremunerative prices. Again with such governments as Russia, Austria, Greece, Turkey, Holland and Denmark, from all whom we have good prospects of business, our established position with the English government is of paramount importance to us.[99]

A policy of heavy investment reduced the short-term return of capital, and generated plenty of organisational and financial issues, but it had the positive side effect of reinforcing the relative position of John Brown and Cammell against that of potential competitors because he large sums required to set up an armour plate mill complicated the entrance of new firms in the market.

This is, for instance, what happened with Beardmore of Parkhead (in East Glasgow). This firm, established in the late 1830s as an iron forge, produced wrought iron plates in the early 1860s for several ironclads which were built in the yards on the Clyde. 3-4 in. wrought iron plates were relatively easy to make, and the proximity of a source of demand stimulated production. Beardmore, however, did not invest to adapt its plant to the production of thicker plates and left the market to John Brown and Cammell.[100] More than twenty five years passed before Beardmore, under very different circumstances, ventured again into armour plate production.

Despite the absence of precise accounting data, armour plates seems to have been a profitable trade, offering good margins. In its first twenty years of activity as a public company between 1864 and 1884, Cammell paid in average a dividend of near 8%. It is not possible, however, to calculate how much resulted from armour production and how much from non-military production.[101] Because different prices can be found in journal articles and documents, it is difficult to assess what was the average price paid for wrought iron plates. Prices between £35 and £45 a ton seems, however, to have been the norm. In addition to orders from the British Admiralty, John Brown and Cammell received orders from several foreign governments. The fact that they supplied the Royal Navy was regarded as an important endorsement of the quality of their production. To advertise their productions, both firms sent trial plates to commercial and industrial exhibitions around Europe (for instance, in Vienna, Moscow, and Berlin) and to the offices of their

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[99] WAS, Cammell, *Minutes of the Meeting of the Board*, 5 September 1868.
[100] J. R. Hume and M. S. Moss, *Beardmore. The History of a Scottish Industrial Giant* (London, 1979), 7-10.
[101] *Colliery Guardian*, 28 March 1884, 508.

representatives abroad.[102] In addition, it is likely that John Brown and Cammell colluded to keep prices high. There is no direct evidence of this, but it would be very surprising if the managements of two firms operating a few miles from each other and with evident common interests (maintaining profitability and blocking new entrants, for example) did not communicate. It is important to remember, however, that armour plate production represented only part of the business of John Brown and Cammell. During the 1870s, for example, the production of steel rails for the American market was their major business.[103]

In the mid-1870s two trends weakened John Brown's and Cammell's position. The first was the emergence of strong competitors in civil production. Firms based in the North East and in South Wales could count on cheaper coal and better connections than Sheffield. Because steel technology had moved to high-scale, low-margin production methods (e.g. open hearth furnaces), these were crucial advantages.[104] At the same time Belgian and German companies increased their operations and sales in foreign market and also in Britain.[105] The second was the introduction in 1876 of steel armour plates by Schneider. The French firm claimed that all-steel plates were lighter and stronger than wrought iron plates of the same thickness. Such a development could seriously threaten John Brown's and Cammell's leadership in armour making, a business which was becoming more and more crucial to them because of the growing competition in non-military steel.

John Brown and Cammell replied by investing in research in order to innovate their products since wrought iron plates were now obsolete. To add urgency to the efforts of the firms there was the fact that the uncertainty about the best course of action in armour plates manufacturing was resulting in smaller orders from the admiralty.[106] Therefore, from 1877, Cammell started to experiment with casting and rolling iron and steel plates of different composition, thickness and shape.[107] John Brown (whose records are less well preserved) presumably did the same because both John Devonshire Ellis and George Wilson registered patents for the production of compound

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[102] Stacey, *Survey*, 12.
[103] Warren, 57-75.
[104] Data of total steel production (both Bessemer and Open heart technology) of various British regions coming from the *Annual Report of the British Iron Trade Association* of 1886 (49) and 1887 (23-32):

	Scotland	Sheffield	North East	North West
1878	–	293,000	74,000	230,000
1886	245,000	278,000	523,000	493,000

[105] U. Wengenroth, *Enterprise and Technology: The British and German Steel Industries, 1865-1895* (Cambridge, 1993), 113-114.
[106] Grant, *Steel and Ships*, 34.
[107] Stacey, *Survey*, 13.

armour plates, that is plates with a face of hard steel backed by wrought iron. From 1879 compound plates became the standard on all British vessels and were also adopted by many foreign navies. Steel was regarded as theoretically superior, but plates of uniform quality were difficult to obtain. The first generation of all steel plates was too prone to brittleness and cracking.[108]

The introduction of compound plates demonstrated the responsiveness and adaptability of John Brown and Cammell. Facing the sudden disappearance of their armour business, the managements of both firms rapidly innovated and retained a leading position in the armour plate market. Cammell, for instance, sold the rights to use its patents to several French firms (among them Marrell Freres). The increased level of complexity in producing compound plates translated into higher prices. During the 1880s compound plates fetched up to £100 a ton, were 19 in. thick and weighted around 50 tons each.[109] Despite the price varying according to size, treatment, etc., it was far superior to that of ordinary steel plates for shipbuilding which sold for £ 4-5 a ton. An example helps to understand the large profits which armour making could generate. Each of the seven vessels of the pre-dreadnought *Royal Sovereign* class, laid down in 1889 and 1890, required around 2,500 compound armour plates.[110] Putting the average price for armour at £ 80 (lower than the price of the largest and thickest plates because not all the parts of a ship were equally protected), a contract for supplying the plates for just a single vessels generated revenues of £200,000.

The drawback was that making compound armour was a more complex process than making wrought iron ones, and both firms had to undertake large investments which, in turn, resulted in a high levels of fixed costs. The growing complexity of armour making made impossible for firms to revert the same plant to different production in the short-term. For armour-making firms, therefore, it became more and more essential to secure a constant stream of orders to keep their works busy and cover fix costs.

1.5 *Conclusions*.

This chapter analysed the evolution of the British private armaments industry in the period 1860-1880. In just two decades the British armaments industry evolved from being virtually non-

[108] See the article on a trial of iron, compound and steel plates carried out in Portsmouth on *The Times* of 20 December 1876.
[109] Stacey, *Survey*, 15-16.
[110] *The Times*, 30 December 1889, 3.

existent to be made of three large and successful firms. The first section was devoted to the analysis of Armstrong's entry into the armaments business, demonstrating how the such a move was the result of a mix of old government policies and new realities. In dealing with Armstrong, British governments followed a traditional pattern. Facing military crises – first in the Crimea, then with France – they enlisted the help of private entrepreneurs to step up armaments production. In the late 1850s, Britain did not face a traditional military crisis, however, one during which more of the same armaments needed to be field; rather it faced a qualitative one, that is one when new kinds of armaments were required to be designed and produced. The new rifled artillery devised by Armstrong drastically reduced the operation value of the old guns. The pressing need to re-equip the country's armed forces pushed governments to use short-term expedients to maximize production. It was in this context that the contract with the Elswick Ordnance Company was signed. However, in 1863, after the emergency terminated, the British government decided to cancel the agreement with Elswick and to reserve to Woolwich the production of its artillery.

What is surprising is that Armstrong's artillery business did not collapse. By contrast, as showed in section three, Elswick thrived despite losing what had been until then its only customer. For all the technical ingenuity of Armstrong and the business acumen of Elswick's managerial team, what kept the company afloat was the introduction of ironclads which created a very favourable environment for the new company to prosper. Many countries, unlike Britain, could not count on large and modern arsenals. Latin American republics, small and medium European powers, Asian governments, all needed to equip their own navies and armies, however small and weak, with modern armaments if they wanted to have even a chance of winning any military confrontation.

Starting in the 1860s military technology entered a period of rapid evolution which has been summarised in section two. Armour plates, rifled guns, screw propellers, explosive shells all contributed to radically change naval warfare. Such evolution favoured Armstrong in two ways: on the one hand, the rapid escalation of size and dimensions of artillery reduced the effective expected life of warships. Hence, the demand for new ordnance was sustained by the unprecedented rate of obsolescence. On the other hand, the average growing sizes of guns increased the difficulties which potential competitors faced to enter the market, thus strengthening Armstrong's position. A comparison between the experiences of Armstrong and Whitworth points, however, to how favourable external circumstances are not sufficient to explain the success of Elswick. Armstrong's success rested on a combination of technical ingenuity, business acumen and a growing pool of potential foreign customers. Armstrong thrived in a period characterised by the absence of conflicts

between powers, but rapid innovation generated the opportunity, for the first time in history, to make private armaments manufacturing activity a promising long-term business. What is more, Armstrong prospered despite, at least until the late 1880s, selling very little in its domestic market, that is Great Britian.

At the same time, the growth of John Brown and Cammell followed a very different pattern, which has been highlighted in section four. While Armstrong thrived thanks to foreign orders, it was the domestic market which represented the largest source of demand for these firms. The British government did not own any plant able to manufacture armour plates, so it had to rely on private firms for them. John Brown and Cammell were able to innovate their production and, thanks to their early entrance, retained well into the 1880s a virtual monopoly in the supply of armour plate for the British Navy.

Chapter II

Armaments for a New Country: Italy, 1861-1880

This chapter analyses the development of the armaments sector in Italy from 1861 to the early 1880s.

In the early 1860s rapidly building up the country's armed forces was a major preoccupation of the Italian governments: in the course of few years both the army and the navy were significantly enlarged and modernised. The rapid evolution of military technology, however, posed an additional problem to the Italian Navy: the introduction of ironclads and rifled guns was radically transforming naval warfare. At the same time, however, the Italian industrial sector was not sufficiently developed to be able to autonomously produce them. the solution which was adopted in the early 1860s was that to import modern armaments from abroad. From 1861 to 1865, Italy went through a buying spree: artillery and even entire ironclads were ordered in France, Great Britain and the United States.

In 1866 the Italian Navy suffered a defeat at the battle of Lissa, a defeat which deeply affected its reputation. The Navy saw its budget substantially cut and its duties limited. Only in the course of the 1870s Italian naval budget started to expand again. This time, however, the growing resources were employed in a different way than in the early 1860s: while at that time it had relied mainly on foreign yards and suppliers, now the Navy either directly built vessels in its own yards, even though still making ample recourse to foreign-made components, or, in the case of small and medium vessels, it awarded contracts to Italian private firms, among which Ansaldo and Orlando were the most important.

The chapter is organised as follow: the first section deals with the trend of Italian naval budget; the second discusses the relationships between the Italian Navy and private suppliers in the 1860s; the third reviews the changing circumstances of the 1870s, and the new role played by private suppliers.

2.1 *Italian naval spending and the evolution of Italian fleet in the 1860s and 1870s.*

Political unification transformed Italy from a mosaic of small states into a major European power. Geography dictated that the country could not be indifferent to naval affairs: at the centre of the Mediterranean Sea, Italy is at the junction between its Eastern and the Western halves. The governments who ran the country for its first fifteen years, however, faced an awkward situation. The wars of unification of the 1850s had squeezed the public finances and the stock of debt was perilously high: Epicarpo Corbino calculated that in 1862 revenues accounted for only half of the total government expenditure.[1] The new kingdom, however, faced new huge expenditures: the Third Independence War of 1866 (which gained Italy Veneto), the move of the capital from Turin to Florence in 1865 and then, in 1871 – after the collapse of the French Empire and the seizure of the Papal States – to Rome. Moreover, the government financed a large infrastructure programme to expand the network of railways and roads, and to modernize ports, aqueducts and other public works. In 1870, public debt peaked at around 92% of national GDP.[2]

Italy faced also a strategic problem. Since the late 1840s Piedmontese foreign policy had been anti-Austrian, the natural consequence of the fact that Austria directly controlled a large chunk of the Padana Valley and exercised a dominant hegemony over the country.[3] All the crucial military encounters of the Independence Wars were fought in the Po Valley, meaning that the Piedmontese navy played a limited role in comparison with the army. Italy's geographical position, however, forced governments to carefully reconsider the country's strategic priorities. After the entire peninsula had been united, and Italy had suddenly became a major Mediterranean power, how many resources should be devoted to the Italian navy? And what aims should the new navy pursue? Italian governments had two choices in front of them. They could decide to limit their involvement in naval affairs, and then confine the fleet to little more than coastal defence duties, or they could embrace a more assertive policy in the Mediterranean and, thus, build a powerful navy.

Figure 2.1 shows the sums which the parliament voted for the Naval budget in the years 1861-70. Two things needs to be underlined. The first is that usually actual expenditures were 5%-15% less then the authorised amount. This occurred for many reasons: contracts were signed later than expected, ministerial bureaucracy took more time to draw spending plans, etc. These residuals, however, were not taken back by the Treasury, but they remained at disposal of Ministry of the

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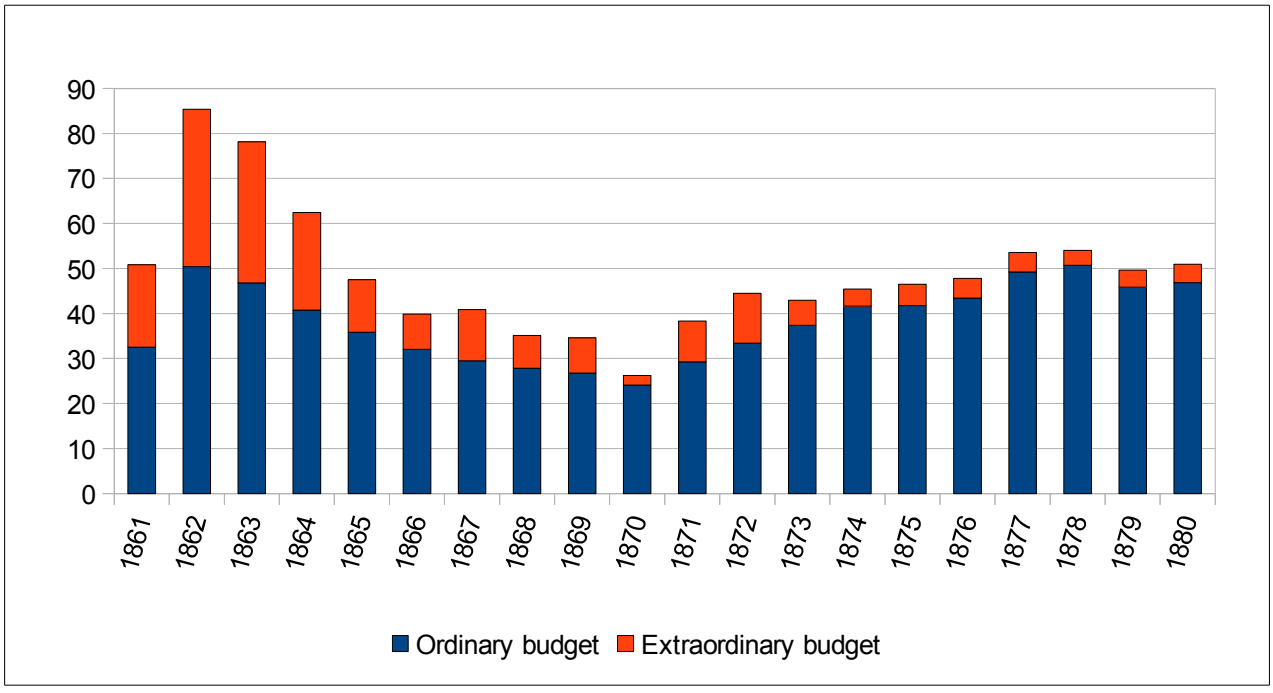
1 E. Corbino, *Annali dell'Economia Italiana, 1861-1870* (Città di Castello, 1931), 37.
2 Id., 281.
3 G. Candeloro, *Storia dell'Italia Moderna.* Vol. 3 *La Rivoluzione Nazionale 1846-1849* (Milano, 1960), 1-132.

Navy to be spent.[4] The choice of using the authorised sums instead of the effective expenditure is justified by the fact that, by adopting this yardstick, it is easier to gauge the intentions of the policy-makers. In addition, the correlation between authorised and effective expenditures is very high.

The second, is the difference between "ordinary" and "extraordinary" parts of the naval budget (the same division occurred also in the army budget). Ordinary expenditures represented the cost of keeping the Navy operative. all recurrent and routine expenditures generally ended in the ordinary part of the budget: payments to seamen and officers, purchases of coal, food, clothes, etc. Extraordinary expenditures, by contrast, were made up of non-recurring items. Rearmament programs, the erection or enlargement of arsenals and yards, and similar expenditures were usually financed by the extraordinary part of the budget. The difference between the two parts was theoretically clear, but in practice there were exceptions which aggravated the general complexity, sometime bordering on outright mystification, of Italian military budgets.[5]

Figure 2.1: Italian Naval expenditure, 1861-1880 (million of current Lire).



Source: *Leggi e Decreti del Regno d'Italia*, various years.

Immediately after the unification, large sums of money were devoted to the navy. In the first Italian national government, the position of Minister for the Navy was personally held by the Prime

[4] F. Degli Esposti, *Le Armi Proprie. Spesa Pubblica e Sviluppo Industriale nell'Italia Liberale* (Milano, 2006), 34.
[5] G. Rochat and G. Massobrio, *Breve Storia dell'Esercito Italiano dal 1861 al 1943* (Torino, 1978), 75.

Minister Cavour, a sign of the importance that he attached to naval affairs.[6] The rapid expansion of the budget was a consequence of the ambitious modernization programme of the armed forces pursued by Italy between 1861 and 1865.[7] In this period the Navy was thoroughly re-equipped: large resources were used to rapidly transform it from a force based on wooden vessels to one equipped with ironclads and modern ordnance: the governments in office had clearly decided that Italy needed a large and powerful Navy. This was very much a decision coming from the political and military elite: the first naval budget was presented in front of the Parliament only in 1863, after large sums had already been spent.[8] A future confrontation with Austria was certain, and a powerful Navy could be decisive in the Adriatic theatre. In the period 1861-65, therefore, it was the extraordinary part of the budget which grew at the highest rate: in both 1862 and 1863 they totalled more than 30 million Lire, around 40% of the total budget. Modernisation equally impacted ordinary spending because more resources were needed to maintain operative a larger fleet. By 1865 the modernisation process was to a large extent concluded. The following year the naval budget felt to 40 million Lire, a sum which was seen as appropriate for the routine maintenance of the fleet.

The defeat suffered by the Italian navy at Lissa shocked the country and it undermined the country's confidence in the navy: a vast amount of money had apparently been spent to no avail. The nominally superior Italian navy had been defeated by the smaller Austrian navy which could field only half the ironclads Italy had.[9] The war caused a large increase of public debt. To deal with the deteriorating public finances, governments resorted to deep cuts in public expenditures and tax hikes. With the Navy's prestige at an all time low, the naval budget was severely cut and the Navy's duties restricted to coastal defence. Ordinary expenditures were halved buy a third, and extraordinary expenditures were virtually eliminated. By 1870, the naval budget had fallen to little more than 26 million Lire.[10] The major consequence of this combination of fiscal retrenchment and military rethinking (helped by the fact that, with the seizure of Veneto, Austrian naval threat appeared less worrisome) was the virtual standstill in constructions: between 1865 and 1872, the

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6 A. Viarengo, *Cavour* (Roma, 2010), 497; R. Romeo, *Cavour e il Suo Tempo,* vol. 3, *1854-1861* (Roma-Bari, 1984), 901. M. Battaglieri, *La Politica Navale del Conte di Cavour* (Livorno, 1942) offers a general, but outdated, assessment of Cavour's naval policy.

7 On the Italian Navy from 1861 to 1866, M. Gabriele, *La Politica Navale Italiana dall'Unità alla Vigilia di Lissa* (Milano, 1958), and id. *La Prima Marina d'Italia (1860-1866). La Prima Fase di un Potere Marittimo* (Roma, 1999).

8 Degli Esposti, *Armi Proprie*, 69-71.

9 A. Iachino, *La Campagna Navale di Lissa 1866* (Milano, 1966) is the standard history.

10 T. Ropp 'The Modern Italian Navy', *Military Affairs* 5 (1941), 38.

parliament did not approve any law financing new constructions. The only ships which were completed were the ones which had already been started before Lissa.

The newly established Italian Navy was the result of the merger between the Piedmontese and the Neapolitan fleets. The unification of the pre-unitarian fleets happened in a moment when naval technology was rapidly evolving with the introduction of rifled ordnance and ironclads. Sailing and steam paddle vessels were rapidly becoming obsolete and needed to be replaced.[11] Extraordinary expenditures were thus used to finance the fleet modernisation, and the creation of a new naval arsenal in Spezia which was intended to replace Genoa as the major base of the Navy: Spezia was easier to defend, and moving the fleet away would free spaces for expanding Genoa as a commercial port.[12]

The Navy had to choose how to spend the money appropriated for the modernisation of the fleet. It had two options. The first was to buy vessels abroad, the second was to build new units in Italy, either in its arsenals or in private yards. The navy owned yards in Genoa, Leghorn, Castellammare di Stabbia (near Naples), and, after the annexation of Veneto, also in Venice. The arsenals of La Spezia and, later Taranto (whose construction started in the 1880s as the main base of the fleet in the South), were also equipped to undertake shipbuilding. In the early 1860s, however, Italian arsenals, as the British ones, had no experience in the construction of iron-hulled ships. Time and significant investments were required to modernised them. At the same time, relying on Italian private yards was unrealistic: immediately after the unification, the Ministry of the Navy created a special committee to investigate if the productions of the mineral, engineering, and iron industries in Italy could be used by the Navy. The assessment was that Italian private yards were too backward to undertake any major naval construction.[13] By contrast, three reasons were in favour of purchasing ironclads from abroad. The first was that some foreign yards had already build ironclads, therefore they could produce better vessels than inexperienced Italian yards. Second, because of their experience, foreign shipyards could manufacture faster, something crucial in a period of rapid

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[11] On Borbonic naval construction see A. Formicola e C. Romano, *L'Industria Navale di Ferdinando II di Borbone* (Napoli, 1993). On Piedmontese warships: F. Degli Esposti, *Le Fabbriche di Marte*, vol. 2, *Gli Stabilimenti Liguri* (San Marino, 2000), 86-97. On the difficult transition from the pre-Unitarian fleets to the new Italian Navy, C. Randaccio, *Storia delle Marine Militari Italiane dal 1750 al 1860, e della Marina Militare Italiana dal 1860 al 1870* Vol. I (Roma, 1886), 281-83.

[12] G. Galuppi, 'L'Arsenale della Spezia nel Centenario della Sua Inaugurazione', supplement to *Rivista Marittima* (1969); Battiglieri, *Politica Navale*, 98-99. On the impact of the arsenal on Spezia, P. G. Scardigli, *1849-1902 Con l'Unità d'Italia la Marina Militare nel Golfo e le Prime Istituzioni Imprenditoriali Spezzine* (La Spezia, 2011).

[13] F. Giordano, *Industria del Ferro in Italia. Relazione dell'Ingegnere Felice Giordano per la Commissione delle Ferriere Istituita dal Ministero della Marina* (Torino, 1864).

technological change to avoid vessels becoming obsolete even before entering service. Third, the Italian Navy needed a large number of vessels to immediately reinforce the fleet. By awarding contracts to multiple yards, it was possible to build a modern fleet of ironclads in just few years.

Hence, for both strategic – reinforcing the fleet as soon as possible – and technological reasons – the inability to undertake the most innovative productions in Italy – the first Italian ironclad fleet was built abroad. As Giacomo Martorelli wrote in an article published in 1911 which analysed the evolution of naval construction in Italy since 1861, "until 1866 all iron hulls for military and commercial vessels, were built abroad".[14]

French shipyards secured the bulk of the orders: the French contribution had been decisive in the Second Independence War and favouring French yards was a way to preserve the alliance. The Forges et Chantiers de la Mediterranée, at la Seyne,[15] built six ironclads (*Terribile*, *Formidabile*, *Maria Pia*, *San Martino*, *Palestro* and *Varese*), the Chantier et Atelier de l'Océan at Bordeaux one (*Ancona*) as the Guin and Guibert yard at St. Nazare (*Castelfidardo*). One vessel was ordered in Britain (*Affondatore*, built by Milwall Iron Works in London)[16] and two from the Webb shipyard in New York (the armoured frigates *Re d'Italia* and *Re di Portogallo*).[17] In total, from 1861 to 1866, the Italian navy purchased ironclads abroad worth more than 36 million Lire, to which should be added other 2,600,000 Lire spent for two small wooden vessels equally ordered abroad.[18] Data on the total salaries of arsenal workers make evident that the substantial orders placed abroad did not translate in a demise of the arsenals. This is certainly a less-than-perfect yardstick to assess the arsenals' operations, but, in absence of better data, it offers a way to gauge their activities. Figure 2.2 shows the sums voted for arsenals' workers salary between 1861 and 1870.

In contrast with the general trend on naval spending, the post-1866 period registered higher values than the previous one. This was because arsenals were involved in maintaining the fleet and

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14 G. F. Martorelli, 'L'Industria delle Costruzioni Navali in Italia (1861-1911)', *Rivista Marittima* 50 (1911), 12.

15 For a description of La Seyne shipyard, J. Tugan, *Le Grandes Usine*. *Ètudes Industrielles en France et à l'Étranger* (Paris, 1868), 305-320.

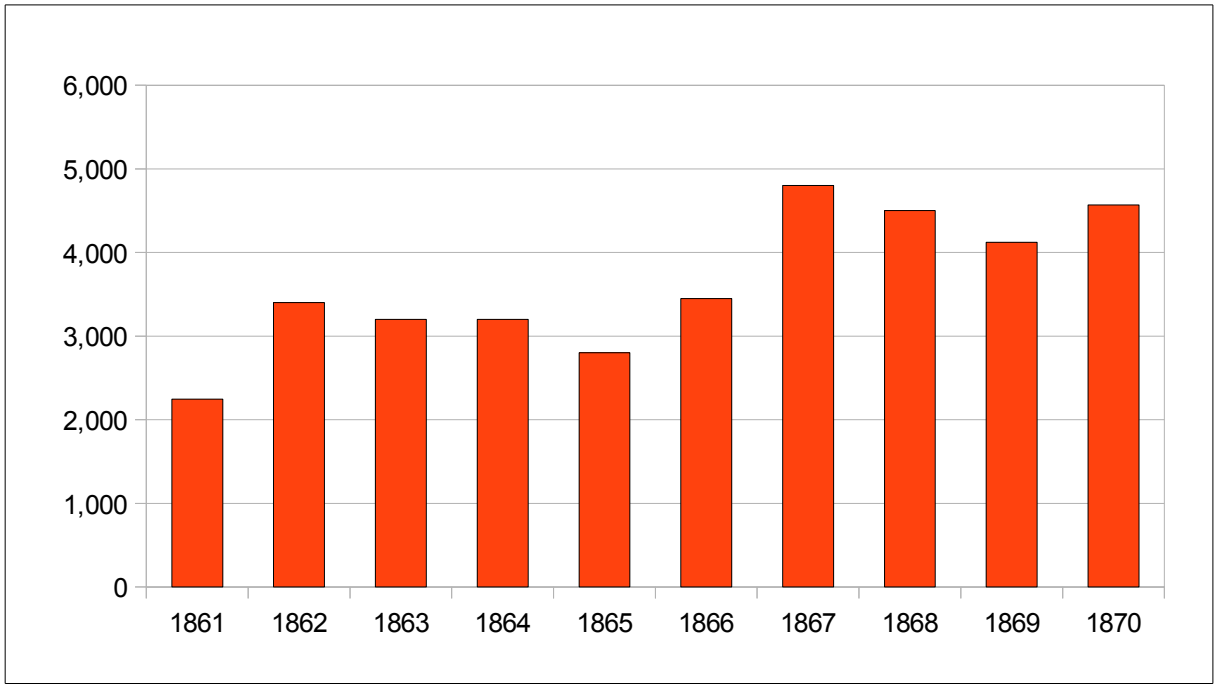
16 A description of the ship is in *The Times* 10 February 1865, 9. The Millwall Iron Works and Shipbuilding Company was established in 1863 by a group of businessmen linked to Overend, Gurney & Company. For a short period of time it ranked among the largest shipbuilders in Britain, employing more than 4,000 workers and undertaking also the production of iron plates and other components. The firm collapsed after the panic over Overend, Gurney & Company and was liquidated in 1871. H. Hobhouse (ed.), "Southern Millwall: Drunken Dock and the Land of Promise", *Survey of London: volumes 43 and 44: Poplar, Blackwall and Isle of Dogs*, (London, 1994), 471-472 offers a description of the works. P. Barry, *Dockyard Economy and Naval Power* (London, 1863), 209-215 presents several pictures of the yard. See also S. Pollard, 'The Decline of Shipbuilding on the Thames', *Economic History Review* 3 (1950), 72-89, who reports that Millwall likely financed a press campaign for the closure of the Royal Dockyards and the transfer of all works to private companies.

17 Technical notes on each ship are in G. Giorgerini and A. Nani, *Le Navi di Linea Italiane. 1861-61* (Roma, 1962).

18 G. Maldini, *I Bilanci della Marina d'Italia* (Roma, 1884), vol. 1, *passim*.

building new vessels. In the years 1861-1867 seven ironclads and two corvettes (all with wooden hulls) were laid down in the Navy's yards, but only three vessels were finished before 1870. Keeping the arsenals working remained a paramount preoccupation for the government which feared disturbances by unemployed men.[19] The yard in Genoa, for instance, built *Venezia* and *Roma*,

Figure 2.2: Total salary of arsenal workers, 1861-1870 (in thousands of current Lire).



Source: Degli Esposti, *Armi Proprie*, 73.

two large and expensive battleships (each costing around 6,500,000 Lire).[20] However, comparing the performance of the Italian arsenals with those of the yards abroad highlights the backwardness of the Italian establishments. Each ironclad bought abroad took no more than 24-30 months to be completed, while, for example, *Roma* took six years to enter into service and the *Venezia*, ten.

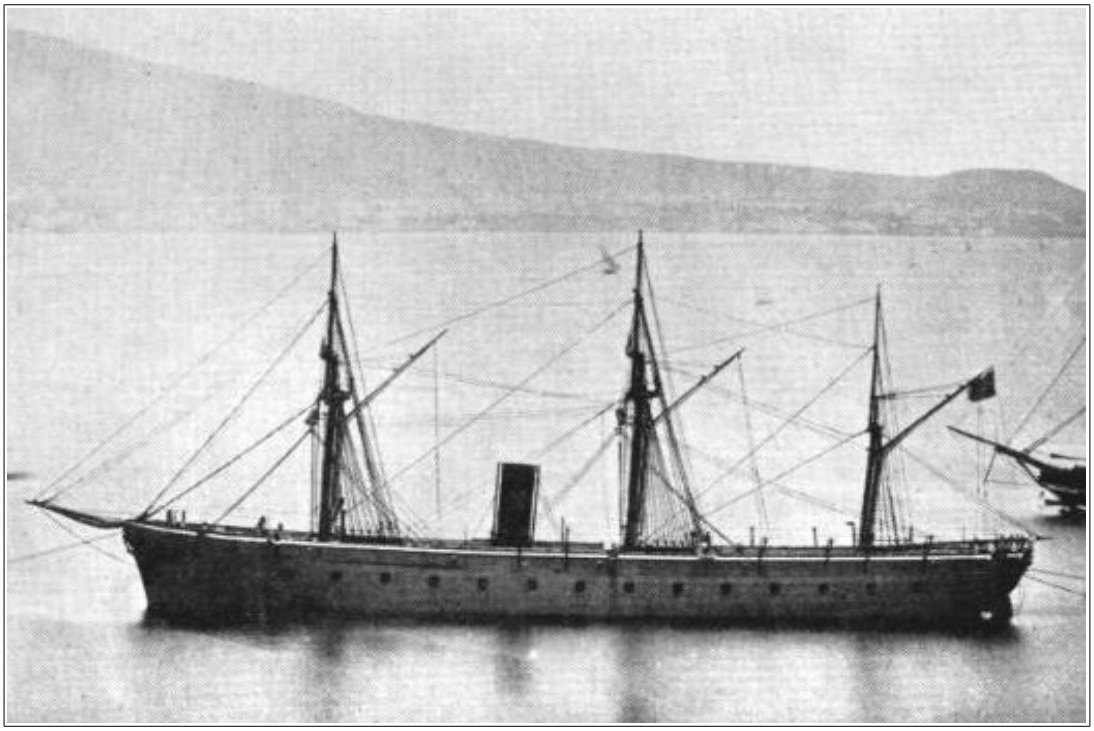
The rapid re-equipment of the navy was no mean feat, at least in financial terms, considering the many commitments faced at the same time by the Italian governments. Militarily speaking, however, the naval build up was less fortunate. On the surface, the Italian Navy had become a force

[19] The records of the Presidenza del Consiglio preserve many letters of prefects, mayors, and businessmen – from both the South and the North of the country – begging the government of the day to provide orders to the yards, arsenals and companies based in their city. See, for instance, ACS, Pcm, 1879/80, b. 23, f. 842, for a letter from the prefect of Naples on the naval yard of Castellammare, and ACS, Pcm, 1879/80, b. 32, f. 219 for from prefect of Genoa in support of Ansaldo.

[20] Bargoni, *Navi*, 21-22. The costs of the vessels built by arsenal are estimates which should then be treated carefully, they are useful more to provide an order of magnitude, rather than precise numbers.

to be reckoned with. While in 1861 it was composed of 79 units, by 1866 the number had grown to 84. Qualitatively changes had been even more profound. In 1861 the Italian fleet was made up only of steam-powered wooden vessels and sailing ships armed with smoothbore artillery. In five years it had been transformed into a force whose core was now composed of eleven ironclads mounting large rifled guns, making it among the strongest navies in the world.[21] Installed steam power doubled, from 12,160 HP to 21,450 HP; guns increased from 745 to 1,125 and the total displacement of the fleet from 77,031 to 133,526 tons.[22]

Figure 2.3: The American-built Italian broadside ironclad *Re d'Italia*, circa 1865.



Source: Wikimedia Commons.

Notwithstanding the large investments, the Navy suffered from a lack of standardisation. The Ministry ordered ships wherever it thought they could be satisfactorily built. The imperative was to rapidly enlarge the fleet so to acquire a decisive superiority over Austria. Coming from so many different yards, however, Italian ironclads differed significantly in terms of designs, size and protection. This lack of uniformity complicated operations. What is more, rearmament occurred while naval technology was still rapidly progressing. The result was that the Italian ironclads were

[21] L. Sondhaus, *Naval Warfare, 1815-1914* (London, 2001), 93.
[22] G. Maldini, *Bilanci*, *passim*.

of the broadside kind and so they were doomed to become obsolete in a few years, when the central battery design, which increase the range of fire of artillery, was introduced.

In the course of the 1870s, Italian naval budget returned to grow. Foreign policy preoccupations pushed Italian governments to increase military spending: the reactionary governments which ruled in France during the first years of the republic antagonised Italy by supporting Pope Pious IX, who still refused to recognise the Italian seizure of Rome.[23] By contrast, the seizure of Veneto in 1866 had reduced the relevance of the Adriatic theatre and, in the course of the 1870s, the Austria fleet declined, starved of funds and, after the death of Admiral Tegetthoff, lacking leadership.[24] The growing hostility with France meant that now the Western Mediterranean would be a major theatre of operation in case of war. The fact that the major Italian ports (Genoa and Leghorn) were on the Western coast of the country made essential their protection from naval bombing. In addition, the beginning of industrial development of Italy underlined how much the country relied on imports of raw materials, the majority of which came by sea, and the opening of the Suez Canal gave new importance to the Mediterranean Sea as a strategic and commercial route. Under these new circumstances, the role of the Italian Navy could hardly be limited to coastal defence. The Navy, however, was made of of the vessels which had fought at Lissa, which, by the standard of the early 1870s, were utterly outdated.

The first step was to replace the outdated broadside ironclads with modern warships. More powerful guns had appeared and thicker armour plates were now required to protect vessels. Until 1876, however, governments were fully committed to balancing the budget, thus the additional resources voted for the naval budget were quite limited, notwithstanding the lobbying of the Navy.[25] The need to built a more powerful Navy under financial constraints had an impact on the design of the vessels and on the nature of hardware which the Italian Navy purchased from Italian and foreign private suppliers.

Figure 2.1 shows the Italian naval spending in the 1870s. Two things are noticeable. The first is that, between 1871 and 1878 there was a steady growth until, by the late 1870s, it reached

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23 G. Spadolini, *L'Opposizione Cattolica da Porta Pia al '98* (Milano, 1994), 12-18.

24 Sondhaus, *Naval Warfare*, 111-112.

25 To increase the interest for the Navy, Carlo Rossi, an employee of the Ministry of the Navy, published in 1872 an adaptation of the British novel *The Battle of Dorking* by George Tomkyns Chesney. To adapt the text to the Italian reality, the German invaders were transformed into French. See C. Rossi (but published anonymously), *Il Racconto di un Guardiano di Spiaggia. Traduzione Libera della Battaglia di Dorking* (Roma, 1872). On the "invasion literature" see I. F. Clarke, 'Forecasts of Warfare in Fiction 1803-1914', *Comparative Studies in Society and History* 10 (1967), 1-25; and id. 'Before and after the *Battle of Dorking*', *Science Fiction Studies* 24 (1997), 33-46.

53-54 million Lire, the same level of the early 1860s. In 1879 there was a temporary reduction which was immediately reversed in 1880. The second is that the growth was driven by increases in the ordinary share of the budget, rather than in the extraordinary. This was because resources devoted to new constructions were now included into the ordinary part of the budget, while, in the 1860s, they had constituted the largest component of the extraordinary expenditures.

The Italian navy decided to make the most of the additional resources it received by adopting a different approach from that which had characterised the early 1860s. First, it adopted the policy of building few, but powerful vessels, rather than investing to acquire a larger number of weaker ones. The Navy stressed the need to acquire innovative ships: Italy could not compete with France in the number of vessels, but could exploit technological innovation to gain military superiority based on quality.

The second change was the drastic reduction of the number of vessels purchased from foreign yards. Before Lissa Italy bought abroad 41,174 tons of ironclads, while only the ironclad *Principe di Carignano* of 3,446 tons had been built in Italy, in the arsenal at Genoa. By contrast, in the 1870s the Italian navy bought abroad only a torpedo boat, *Nibbio*, which was ordered from the British firm Thornycroft. Instead, the bulk of naval constructions was undertaken in Italy, in the majority of cases in the Navy-owned arsenals which built 43,502 tons, equal to 76,5% of the overall displacement of new battleships and cruisers (56,838 tons). The remaining 23,5% was made up by the battleship *Lepanto*, built by the Orlando yard in Leghorn. The special circumstances of the early 1860s had forced Italy into a spending spree abroad to rapidly rebuilt its Navy. As soon as its yards were reorganised to make iron hulls, though, the Navy moved shipbuilding there, so to enjoy a higher degree of control on the design and characteristics of vessels. For instance, the battleship *Venice* was laid down as a broadside ironclad, but during construction it was transformed into a central battery ironclad. It was also strategically essential to have the possibility of relying on domestic shipbuilding capacity. To save money and concentrate production some of the smallest state-owned arsenals and yards were sold, as those in Genoa and Leghorn.[26]

Hull construction, however, was only a step in the process of building a warship, and the simplest one. Italy was still fully dependent upon foreign suppliers for two key components: armour plates and ordnance. Sometimes, naval engines (especially in the case of the largest ones) were also bought abroad. Building vessels in Italy represented an important step as it gave to the Italian Navy

[26] On the sale of Leghorn yard, see below; on the one in Genoa, G. Doria, *Investimenti e Sviluppo Economico a Genova alla Vigilia della Prima Guerra Mondiale*, vol. 1, *Le Premesse (1815-1882)* (Milano, 1969), 73-74.

more freedom to develop vessels which were coherent with its strategic and tactical needs and increased, at least partially, the country's military security, although the still limited experience of the Navy's yards in iron construction meant longer construction times. The crucial role of foreign suppliers is highlighted by data showed in figures 2.4 on the purchases of hardware and components (excluding shipbuilding contracts) made by the Navy in the period 1870-1880.

Figure 2.4: Purchases from Italian and foreign private companies, 1870-1880 (in current Lire):

Year	Purchase from Italian private companies	As percentage of total purchase	Purchase from foreign private companies	As percentage of total purchase	Total
1870	817,249	29.1%	1,990,930	70.9%	2,808,179
1871	1,081,808	71.2%	438,169	28.8%	1,519,977
1872	3,133,063	29.5%	7,496,821	70.5%	10,629,884
1873	972,095	45.7%	1,157,139	54.3%	2,129,234
1874	707,458	10.3%	6,157,828	89.7%	6,865,286
1875	1,410,606	60.7%	911,774	39.3%	2,322,380
1876	3,442,044	31.6%	7,438,888	68.4%	10,880,932
1877	1,500,786	12%	11,000,188	88%	12,500,974
1878	1,353,281	67.5%	651,789	32.5%	2,005,070
1879	894,536	34.2%	1,722,209	65.8%	2,616,745
1880	2,775,118	27.8%	7,224,620	72.2%	9,999,738

Source: *Inchiesta Parlamentare sulla Marina Mercantile (1881-1882)*, vol. 1 (Roma, 1882), 450-465.

The above figures make evident two things. First that the Navy still bought abroad a large amount of supplies. In qualitative terms, the predominance of foreign firms was still more accentuated, because they supplied the totality of the most high technology components – guns and armour plates – which were not manufactured in Italy. Second, that the purchases made in Italy were irregular: few "good" years (1872, 1876 and 1880) were followed by "poor" ones. In general, additional resources appropriate to the Navy did not necessarily translate into more orders for Italian firms.

At this point it is interesting to underline the different situation between the Navy and the Army. If the Italian navy wanted to play a role, it had to adapt itself to technological evolution.

Naval warfare was becoming more and more capital intensive: the penetration power of guns, the strength of armour plates, the endurance and speed of engines were now decisive factors in case of conflict. Therefore the Italian navy was pressed to acquire modern materiel, or to slip into irrelevance. If the most advanced technology was manufactured abroad, it had no option but to purchase it from foreign suppliers. In contrast, land warfare was much less capital intensive and not so dominated by the impact of continuous technical improvements, and innovation in field artillery but did not occur at the same speed as in warship design and naval armaments. The materiel of the Italian Army, therefore, was not subject to the same level of technical obsolescence of that of the Navy. Therefore the Army was still able to rely to a large extent on public arsenals, which supplied it with rifles, bayonets and guns. Foreign hardware was imported, as it happened in 1872, when several large rifled guns were purchased from Krupp,[27] but until the early 1900s the army remained to a large extent indifferent to the private armaments industry.[28]

The trends described above started under Admiral Simone Pacoret De Saint-Bon, Minister for the Navy from 1873 to 1876.[29] Saint-Bon appointed as his chief adviser the naval engineer Benedetto Brin, a brilliant technician, possibly the best Italian naval architect before 1914. Brin was trained at the school of the French *Genie de Marine* and throughout his career he remained in contact with the leading naval engineers of his time. In 1871, for instance, he delivered a paper on hydraulic propellers at the Royal Institute of Naval Architects in London.[30] He designed the majority of Italian battleships until the 1890s. Saint-Bon and Brin agreed that the Italian fleet, given the constraints on its budgets, should focus on few, but powerful and technologically superior, warships to counterbalance the quantitative advantages of other countries.

The result of this strategy were the warships *Duilio* and *Dandolo*, the first battleships in the world which relied exclusively on steam, lacking masts and sails to provide for auxiliary propulsion. *Duilio* and *Dandolo* were much bigger than the warships of the previous generation: they displaced more than 11,000 tons, while the average ironclad of the 1860s less than 6,000 tons. Both vessels was designed to carry just four very powerful guns. A single ship could thus gain decisive tactical superiority over an entire enemy fleet made up of smaller and less armed vessels. Given their size, their construction represented a challenge to the navy's shipyards of

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27 Camera dei Deputati, *Documenti*, 'Provvista di Materiale d'Artiglieria da Campagna di Grosso Calibro' (2 February 1875), 1-3.

28 Rochat and Massobrio, *Esercito*, 122.

29 Waiting for the *DBI* to arrive at the letter "S", E. Prasca, *L' Ammiraglio Simone de Saint-Bon* (Roma-Torino, 1906) offers the only (complimentary) biography.

30 A. Capone, 'Benedetto Brin', *DBI*. A more recent biography is M. Gabriele, *Benedetto Brin* (Roma, 1998).

Castellammare di Stabia (which laid down *Duilio*) and La Spezia (which built *Dandolo*), tooking longer than expected: eight years elapsed before the vessels were commissioned. Initially, *Duilio* and *Dandolo* had to be armed with Armstrong's 38 ton rifled guns, but because the construction of the ships took longer than planned, the Italian Navy decided to acquire the larger ML 50 ton (355 mm) rifled guns, which Elswick had started to manufacture. Eventually, the ships were equipped with the still larger 100 ton (450mm) ML guns, the largest ever produced up to that time, capable of throwing a shot weighting near a ton.[31]

Figure 2.5: Portrait of Benedetto Brin wearing the uniform of General Inspector of the Italian Naval Engineering Corp.

Source: Wikimedia Commons.

The two warships achieved their major aim, that of transforming the Italian Navy again into a proper fighting force. Suddenly, with just two vessels, the Italian Navy regained a leading position in the Mediterranean: there was no vessel which could withstand unscathed a salvo of their massive

[31] P. Brook, 'Armstrongs and the Italian navy', A. Preston (ed.), *Warship 2002-2003*, 112. A detailed description of the 100 ton gun is in *The Times* 24 October 1876, 4.

100 ton guns. The launch of the *Duilio* created headaches in Paris and London.[32] The British Admiralty decide to respond by launching HMS *Inflexible*, whose design was very similar to that of *Duilio* although it mounted 80 ton guns instead of 100 ton ones, but the British Government bought from Armstrong four 100 ton guns which were installed in Gibraltar and Malta.[33]

In 1876 the so-called "historical right", the agrarian and liberal coalition which had governed Italy since 1861, collapsed after it finally succeeded in balancing the national budget.[34] Benedetto Brin succeeded Saint-Bon as Minister in the new centre-left government. While in office, Brin pursued the policy of building large and powerful battleships. The same year two additional capital ships were laid down: *Italia* and *Lepanto*. Once again Brin designed innovative ships: he rejected side armour in favour of an internal cellular structure designed to minimize the risk of sinking in case the vessels were hit. Brin calculated that modern guns were so powerful that no armour plates could resist them. The reduction in weight allowed *Italia* and *Lepanto* to achieve 18 knots of speed; for years they remained the fastest battleships in the world. Large vessels were obviously very expensive: *Italia* alone cost 24,108,963 Lire, which was equal to two thirds of the entire naval budget of 1871.[35] Notwithstanding the fact that the costs of the new battleships were spread on various years, their construction represented a significant financial burden.

2.2 *Italian and foreign armaments firms in the 1860s.*

The sudden increment in military expenditure caused by the 1859-60 military campaigns, the persistent state of low intensity warfare in the South, the threat of Austrian aggression, and the modernisation of the armed forces represented an exceptional opportunity for business. A comparison between the activities of foreign and Italian firms, however, highlights the different roles they played.

Construction orders were not the only opportunities created by the Italian naval build up. For instance, it offered the first opportunity for Armstrong to sell its guns to Italy: Italy needed rifled ordnance to arm its new fleet but, as in the case of naval construction, there was no Italian firm which could manufacture it. By contrast, Armstrong was in the position to offer exactly what Italy

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[32] *The Times* devoted fourteen articles to the *Duilio* in 1876 alone.
[33] One of these gun is still visible at Fort Rinella in Malta.
[34] F. Cammarano, *Storia Politica dell'Italia Liberale (1861-1901)*, (Roma-Bari, 1999), 74-76.
[35] *Brin*, 313.

required. Stuart Rendel stated in his *memoirs* that Captain Augusto Albini, a naval officer who was in London from 1862 to 1872, first supervising the building of the *Affondatore*, and then working as military attaché at the embassy, had a key role in facilitating business with Italy.[36] The links between Albini and Armstrong's management developed over many decades. Albini was a very well connected officer: his father had been a rear admiral in the Piedmontese Navy and his elder brother was also admiral.[37] Albini, moreover, had a personal interest in technical matters: he designed several gun mountings and a rifle.[38] Albini was, then, in the position of understanding the technological innovations which were reshaping naval artillery and ship design and being in London he could carefully follow these advances first hand, thanks to the many trials organised.[39] The personal contact between Albini and Rendel facilitated Armstrong. As a result, in 1865 contracts for a large number of 150-pounder worth more than £100,000 were signed.[40] With war with Austria looming, Albini tried also to buy the guns for a frigate which Chile had ordered from Elswick.[41] Because the Austrian government also bought guns for five ironclads from Armstrong, artillery for the two belligerents was, ironically, manufactured side by side (although the guns for Austria were not delivered until after the end of 1866), not the only time Armstrong supplied at the same time countries on the verge of fighting each other.

While Armstrong supplied the Italian Navy with up-to-date ordnance, the rearmament policy offered domestic firms the opportunity to receive orders for less sophisticated goods. Among these firms Ansaldo and, later, Orlando, were the most important. In 1846 Fortunato Prandi, a Piedomontese businessman active in Italy and in Britain, joined Philip Taylor, a British mechanical engineer who had created what later became the Forges et Chantiers de la Mediterranée at la Seyne,[42] to establish an engineering company in Genoa. Their aim was to create a "great mechanical establishment devoted to making various machineries and railways material, as well as the material required by the Navy and the shipping merchant industry."[43] These words were pronounced in 1853

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36 S. Rendel, *The Personal Papers of Lord Rendel* (London, 1931), 278. On Albini, see M. Gabriele, 'Albini, Augusto', *DBI*.

37 Id., 'Albini, Giovanni Battista', *DBI*.

38 The rifle was known as Albini-Braendlin after Francis Braedlin, the English gunsmith who perfected Albini's design. It was adopted by Belgium in 1867 and remained in service until the 1870s, D. Westwood, *Rifles, and Illustrated History of Their Impact* (Santa Barbara, 2005), 50.

39 In 1868 Albini published an article which offered a detailed description of the manufacturing process of the Armstrong guns, A. Albini, 'Informazioni sulla Costruzione dei Cannoni Armstrong', *Rivista Marittima* 9 (1868), 599-614.

40 T&W, *Rendel Papers*, 31/152 and 31/153.

41 Id., 31/163 and 31/164.

42 J. G. Alger, 'Taylor, Philip', *ODNB*.

43 Camera dei Deputati, *Atti Parlamentari*, *Relazione del Ministro delle Finanze Camillo Benso di Cavour a Progetto di Legge Presentato il 25 Febbraio 1853*, 243.

by Cavour, at that time Minister of Finance. That Piedmontese government was so well informed because it had, in fact, financially supported the creation of the plant offering Prandi and Taylor an interest-free loan of half million Lire which was decisive for the creation of the firm.[44] As Marco Doria writes: "the capital brought to the company totally came from the government; there was no risk for Taylor and Prandi."[45] The government had bee keen to offer its backing to Prandi and Taylor's venture because the establishment of a firm which could make the railway material needed for the planned Genoa-Turin line was coherent with its desire to strengthen the economic base of the kingdom. Prandi and Taylor wanted to exploit the opportunities arising from the first railway constructions, hoping to find a market for railway engines, carriages, and other machinery. Moreover, the location of Genoa, one of the more economically dynamic areas of Italy could offer additional opportunities for the manufacture of boilers, naval engines and other mechanical productions.[46]

These hopes, however, did not translate into a substantial stream of orders and, from the limited records that survive from this period, it seems that the company mainly satisfied the local demand for mechanical goods. Taylor and Prandi's plant produced many different goods: tanks for the Navy, steam engines for mills, railway engines, carriages and small cranes. While the government had offered tangible financial support, neither it, nor the armed forces gave any significant orders to the firm (the majority of the railway material was bought in Britain).[47] The heterogeneous demand and the lack of the technical know-how did not allow the firm to compete in the most sophisticated markets or to specialise in any given field, so to gain the economies of scale and experience needed to lower its prices and increase the quality of its output and then become able to compete with foreign producers.

In 1852 Taylor and Prandi, dissatisfied by the results, making use of a clause in the agreement they had signed with the government, transferred the ownership of the Taylor & Prandi to the government, which, in turn, immediately sold it to a group of businessmen from Genoa for 810,000 Lire.[48] The firm was restructured as a limited partnership as Giovanni Ansaldo & Co., from

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44 The text of the agreement between the government and Taylor and Prandi is in E. Gazzo, *I Cento Anni dell'Ansaldo 1853-1953* (Genoa, 1953), 119-22.

45 M. Doria, 'Le Strategie e l'Evoluzione dell'Ansaldo', V. Castronovo (ed.), *Storia dell'Ansaldo.* Vol. 1 *Le Origini 1853-1882* (Roma-Bari, 1994), 78.

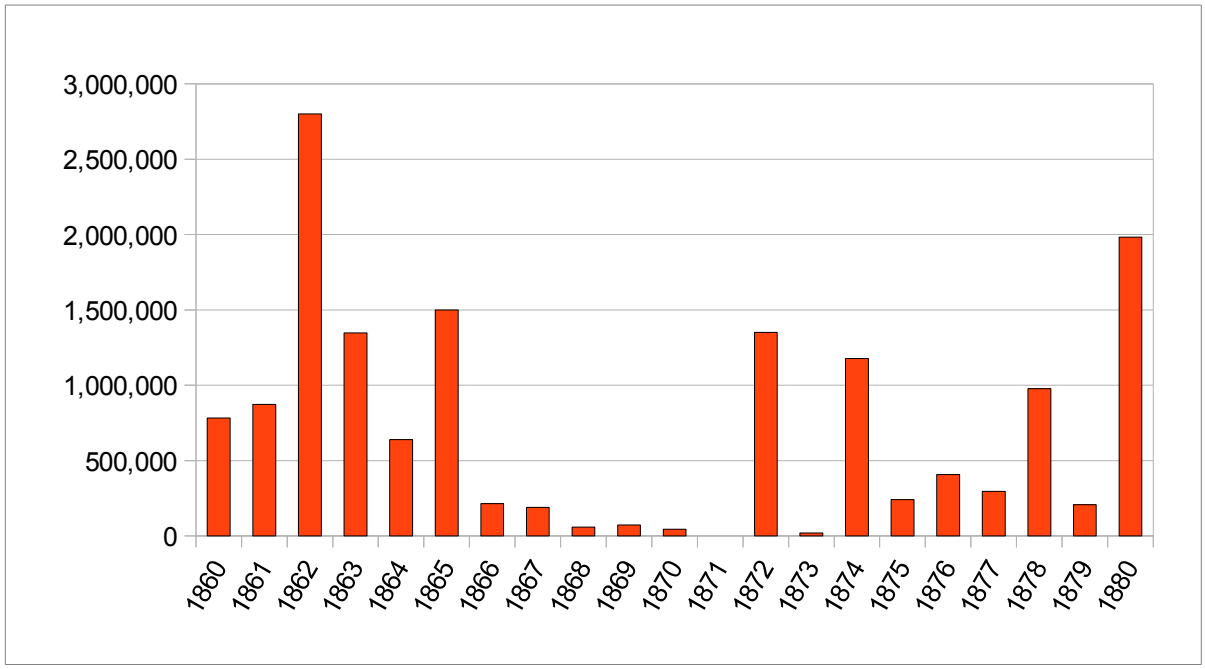
46 G. Doria, *Investimenti e Sviluppo*, 25-46.

47 Of the 1,296 railways engines bought by Italian railways companies between 1871 and 1884, only 231 were made in Italy, M. Merger, 'Un modello di Sostituzione: la Locomotiva Italiana dal 1850 al 1914', *Rivista di Storia Economica* 3 (1986), 66-106; and S. Fenoaltea, 'Le Costruzioni Ferroviarie in Italia, 1861-1913', *Rivista di Storia Economica* 1 (1984), 27-57.

48 Camera dei Deputati, *Atti Parlamentari*, *Relazione*, 245.

the name of the new general manager, the engineer Giovanni Ansaldo.[49] The most important shareholder was Carlo Bombrini, general director of the Banca Nazionale, the major bank in the kingdom and the one enjoying the privilege of issuing banknotes.[50] After Ansaldo's death in 1859, Luigi Orlando, a Sicilian engineer who had emigrated to Genoa in the 1850s for political reasons, became general manager until 1866, when he moved to Leghorn to supervise the shipyard which his family had purchased from the government. Orlando was replaced by Mr. Wehrli, a foreign born engineer of whom little is know, and by Pietro Peirano, an employee of the Banca Nazionale.

Figure 2.6. Value of contracts awarded by the Italian Navy to Ansaldo, 1860-1880 (in current Lire).



Source: Gazzo, *Cento Anni*, 162-166.

Data on contracts received by the Navy are shown in figure 2.6. Only in 1860 did the Piedmontese navy start to award contracts to Ansaldo, when the firm received a contract for casting shells (317,000 Lire) and one for the hulls of two gunboats (191,000 Lire). These were the first military-related contracts Ansaldo received in its history. In 1861 a second contract for supplying shells was signed (328,000 Lire). In 1862 Ansaldo was selected to rifle old smoothbore guns (181,000 Lire), and to forge wrought-iron armour plates (104,000 Lire). The following year the

[49] F. Sirugo, 'Giovanni Ansaldo', *DBI*.
[50] R. P. Coppini, 'Carlo Bombrini Finanziere e Imprenditore', V. Castronovo (ed.) *Storia dell'Ansaldo* Vol 1., 51-75. See also M. Fratianni e F. Spinelli, *A Monetary History of Italy* (Cambridge, 1997), 61-64.

company received a contract for casting one hundred 40 pound bronze guns for a sum of around 2,000,000 Lire.[51] Additional smaller orders were also received. In the period 1861-62, because of these large orders, the company employed around one thousand workers, a number which was not matched during the next two decades.

During the early 1860s the relationship between Ansaldo and the Italian government followed what was the traditional pattern of military procurement for centuries: when the country faced a military crisis, the demand for military hardware of every kind ballooned and the government had to enlist the help of private firms to rapidly expand production. Ansaldo, the largest engineering firm in the kingdom, consequently received large orders until the mid-1860s.

An analysis of Ansaldo's productions, however, shows the precariousness of the firm's position as a supplier of military hardware: Ansaldo's output was hopelessly outdated (bronze cannons, for instance, were rapidly being abandoned) and uncompetitive. To adapt to the new technical paradigm, the Italian Navy decisively moved towards buying guns, plates and, sometimes, entire ships from foreign firms selling up-to-date hardware. It is possible to speculate that, if in the late 1850s technological progress had not kicked off a radical innovation of naval warfare, Ansaldo would have been able to secure a leading position as supplier for the enlarged Italian armed forces. Technical innovation, however, radically altered market conditions, awarding a significant premium to the most modern products, while penalising firms which could not make them.

The business environment in which Ansaldo operated was also worsened by the drastic cut of Italian military spending after 1866. From mid-1860s to the early 1870s, Ansaldo received practically no orders from the Navy: Ansaldo was now competing in a much more limited number of fields – artillery and armour were now bought abroad – and for a rapidly shrinking pool of resources. The growth of naval budget in the 1870s had a positive impact on the orders received by Ansaldo, but the peak of activities of 1861-62 was not matched for more than two decades. To indicate how crucial naval orders were for Ansaldo, it must be underlined that in the period 1860-1881 orders coming from the Italian Navy accounted for 55% of the company's turnover.[52]

The company's response was to shift its focus towards steam engines, boilers and other mechanical productions for the naval sector. From 1863 onwards, the lion's share of the Navy's orders was represented by these kinds of products.[53] In 1863, Ansalso received the order for the 600

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[51] ACS, Ministero della Marina, Direzione Generale dei Servizi Amministrati, Divisione Affari Legali, Serie 'Contratti', various years. The precise amount of the contract for casting guns is an unspecified sum between 1,500,000 and 2,000,000 Lire.

[52] Gazzo, *Cento anni*, 285-86, 290-91 310-11.

[53] Calculations based on data from *Inchiesta Parlamentare sulla Marina Mercantile (1881-1882)* (Roma, 1882), vol. 1,

HP engines of *Conte Verde*, a wooden frigate, for 825,000 Lire. A year later Ansaldo was awarded the contract for the 900 HP engines of *Palestro*, for 1,314,000 Lire. Ansaldo, however, did not design these machines, butt built them on the basis of plans provided to it by the Italian navy, which in turn had bought them from Maudslay & Sons of London.[54]

Ansaldo's position was weakened by the fact that, at the same time as its major customer, the Italian Navy, was cutting expenditures, it was unable to secure significant orders from private customers. The Italian shipping industry was still predominantly based on sailing vessels.[55] Steamers were usually imported from abroad, especially Britain. Ansaldo obtained a few orders for naval engines, but the majority of its activities for private customers was made up by repairs, maintenance and sundry small engineering orders. The late 1860s were therefore a very difficult moment for Ansaldo, whose workforce felt year after year. In 1871 it received no order at all from the Italian navy. As Andrea Saba points to, Ansaldo was squeezed between, on one side, foreign competitors which, quoting lower prices and offering more advance products, limited the markets in which it could compete, and, on the other side, by government arsenals, which, in times of financial constraint tended to be favoured by the central administration.[56]

The building programme pursued by Saint-Bon and Brin in the course of the 1870s had a positive, if limited, effect on the private sector. Among the firms which profited from it was Ansaldo which received some much-needed contracts for the supply of large forgings for the construction of *Duilio* and *Dandolo*, as well as orders for the engines of several smaller vessels. To reinforce its position in naval engineering, Ansaldo's management decided to invest to modernise the plant. New machines were purchased in Britain and the company also hired British skilled craftsmen to train its workforce. The results of these efforts were mixed, as was recognised in an internal document which stated that Ansaldo's productions "might well compete with British goods [in quality], but they are too expensive".[57]

In addition to this, Ansaldo ventured into shipbuilding. Two reasons explain this move. First, it strengthened Ansaldo's position in the market for engines for small and medium vessels. By offering to build hulls and engines together, Ansaldo could exploit the qualitative advantage it had in naval engines making, which, at that time, represented the largest component of Ansaldo's

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450-465.

54 E. Bagnasco, 'Le costruzioni Navali', Castronovo (ed.), *Storia dell'Ansaldo*, 222.

55 Until 1900, the total displacement of Italian sailing ships was higher (568,000 tons) than that of steam ships (377,000 tons), B. R. Mitchell, *European Historical Statistics* (London, 1981), Table G.4.

56 A. Saba, 'Produzioni e mercati', Castronovo (ed.) *Storia dell'Ansaldo*, 175.

57 AFA, *Fondo Bombrini Parodi*, b. 4, f. 2.

activities. For this class of warships, engines represented a proportionally higher percentage of the final cost than in the case of capital vessels, because they were not protected by armour plates and were lightly armed. Second, the ability to offer engines together with the entire ship allowed Ansaldo to compete in the market for merchant ships, where it was rare that machinery and construction were purchased from different suppliers. Civilian orders could help Ansaldo to deal with the ups and downs of military expenditure. In general, the fact that Genoa had a long tradition in shipbuilding facilitated such a move because there was a large pool of skilled workers and widespread know-how which Ansaldo could use. In 1876 the small iron-hulled reconnaissance vessel *Staffetta* (1,366 tons) was launched, the first ship built by Ansaldo, which also supplied its engines. However, the location chosen for shipbuilding – the beach in Sampierdarena in front of the engineering plant – was badly chosen because it lacked sufficient depth and all ships longer than 25-30 meters were in danger of running aground at the launch.[58]

In the late 1870s Ansaldo strengthened its position in the market for naval engines, receiving orders for more than 3,000,000 Lire in the period 1878-1880. In general naval engines, boilers and engine reparations contracts represented 61% of the value of all the contracts Ansaldo received from the Italian navy in the period 1855-1882, for a total sum of 10,063,411 Lire. The predominance of engine making was still bigger in the period 1866-1882, when it accounted for 70,9% of the value of all the Italian Navy's contracts.[59]

The end-of-year results reflect the difficulties Ansaldo experienced, notwithstanding its success in naval engine making and its new venture into shipbuilding. In the period from 1863 to 1882, Ansaldo did not post any profit. The company lost on average of 300,000 Lire a year. As a consequence, by 1882 Ansaldo had accumulated a total of 5,966,548 Lire of loses.[60] Ansaldo's problems can be gauged also by the decline in the workforce, which fell from around 1,000 in the early 1860s (admittedly a period of intensive activity) to around 300 in the late 1870s. Marco Doria claims that during the first two decades of its life Ansaldo suffered from "lack of strong entrepreneurship".[61] There is no doubt that the management was not above criticism. At the same time, the firm's major shareholder, Carlo Bombrini, was too involved in running the Banca Nazionale to offer much strategic direction. There is no doubt, however, that the single major problem Ansaldo faced was a lack of constant demand.

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[58] See the article on the newspaper *Il Caffaro*, 23 June 1876, on the launch of the *Staffetta*, which went aground and required five days of work to get afloat again.

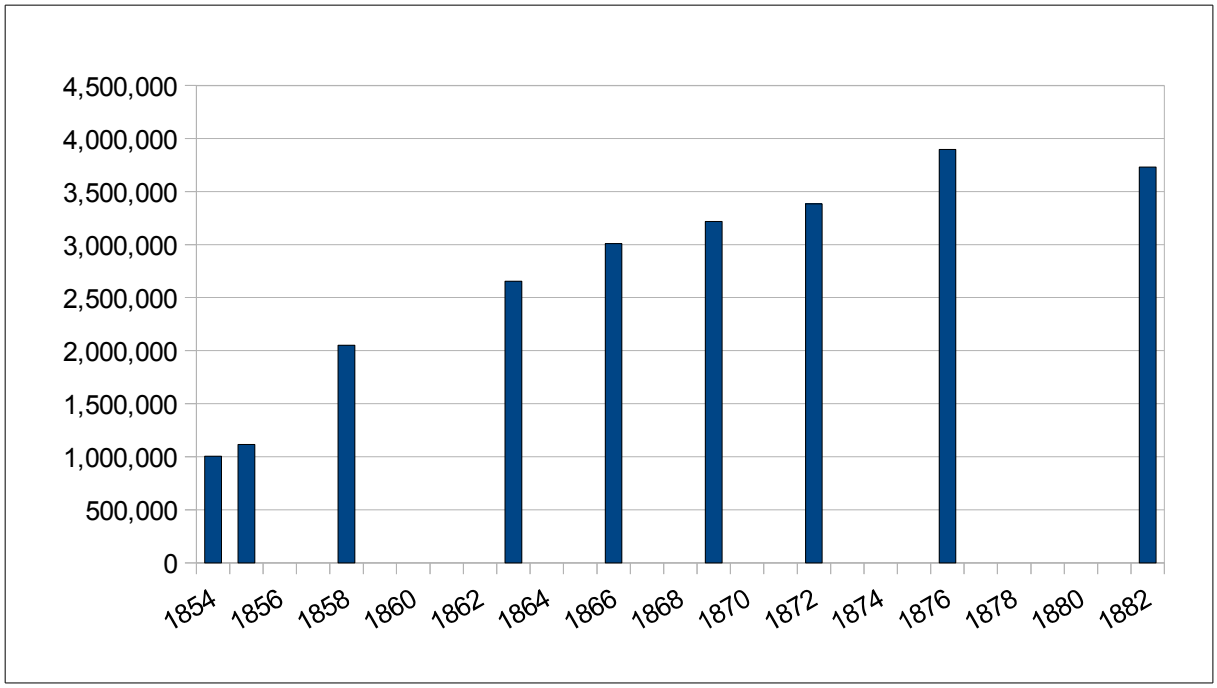
[59] Calculation based on the list of contracts reported by *Inchiesta Parlamentare sulla Marina Mercantile*.

[60] AFA, *Fondo Bombrini Parodi*, box n. 9, file n. 1, 'Prospetti sullo stato patrimoniale dell'azienda.'

[61] M. Doria, *Ansaldo: l'Impresa e lo Stato* (Milano, 1989), 32.

Poor results had an impact on the firm's investments. The early 1860s were a booming period, but, after the reduction in military expenditure, Ansaldo was not able to rapidly adapt its operation to the new technological paradigm in gunnery and armour plates. At the same time, the unfavourable market conditions made it impossible for Ansaldo to gain the scale of operations required to turn into profits its expertise in naval engines. Figure 2.7 shows investments in plants and machinery: by 1866, Ansaldo had invested around 3,000,000 Lire in fixed assets. By contrast, in the subsequent fifteen years, less than one million was invested.

Figure 2.7: Book value of Ansaldo's plant and machineries, 1854-1882 (in current Lire):



Source: AFA, Fondo Bombrini Parodi 9/1.

In these difficult circumstances, the financial support which the Banca Nazionale offered to Ansaldo was decisive for the survival of the firm. By 1882 Ansaldo owned the bank more than ten million Lire.[62] To regard the bank's behaviour as a precursor of the mixed banks' policy of supporting industrial development seems wrong. It was rather Bombrini's role as general director which largely explains why the bank kept financing the struggling firm, although the records are silent on this. Despite the quality of Ansaldo's products, the financial performance of the firm was simply too negative to motivate such a long standing backing. It is likely that, in addition to

[62] Id., 42-43..

Bombrini's double role as the bank's director and Ansaldo's major shareholder, other motivations strengthened the link between the firm and the bank: after Ansaldo had borrowed millions, the bank faced the possibility, in case it stopped supporting the firm, of suffering huge losses on the sum it had lent as well as large reputational damages. It is probable, therefore, that the bank kept lending money with the hope that one day Ansaldo would be in the position to repay the loans.

Another Italian firm which received a significant share of orders from the Navy during the same period was Orlando's shipyard in Leghorn. Luigi Orlando was born in Palermo in 1814.[63] He was forced to emigrate to Genoa after the failure of the 1848 revolution in Sicily which he had supported. In Genoa, together with his three brothers, he established an engineering plant and a small yard where, in 1855, they launched the merchantman *Sicilia*, the first iron-made Italian ship.[64] In 1859, after the death of Giovanni Ansaldo, he became the general director of Ansaldo. Given his past experience in shipbuilding, it is likely that it was Orlando's idea to push Ansaldo into naval engine making. Orlando was at the helm of the company during the hectic period at the beginning of the 1860s when, thanks to his political contacts, he helped secure orders for Ansaldo. In 1865 he resigned to take over the Leghorn yard which the government had decided to sell. The small yard, which the Italian government had inherited when Tuscany was annexed to Italy, was regarded as unnecessary in light of the construction of the much larger arsenal in Spezia only 75 kilometres away from Leghorn.[65] The government leased the yard to Orlando for only 3,200 Lire a year for thirty years to encourage the venture.[66] Orlando's company was later to become one of the major shipbuilding firms in Italy.[67]

Figure 2.8 shows the total tonnage of military and commercial vessels launched at the Orlando's shipyard from 1866 (the year in which the government sold the yard) to 1880. In interpreting the trend for military construction it should be kept in in mind that the figures are based

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63 No scholarly biography of Luigi Orlando exists. Some information on him can be found in the Archive of the Senate to which he was appointed later in life. Among the documents kept there there is also the transcription of the commemoration pronounced in 1898 by the President of the Senate Domenico Farini after Orlando's death which offer a brief synthesis of his life. The text is available on line: http://notes9.senato.it/Web/senregno.NSF/e56bbbe8d7e9c734c125703d002f2a0c/feff59989c832ea94125646f005df904?OpenDocument. In addition, a commemorative volume sponsored by the Orlando family was published soon after his death: P. Levi, *Luigi Orlando e i Suoi Fratelli per la Patria e per l'Industria Italiana. Note e Documenti Raccolti e Pubblicati per Voto del Municipio Livornese e a Cura della Famiglia* (Roma, 1898).

64 Id., 81.

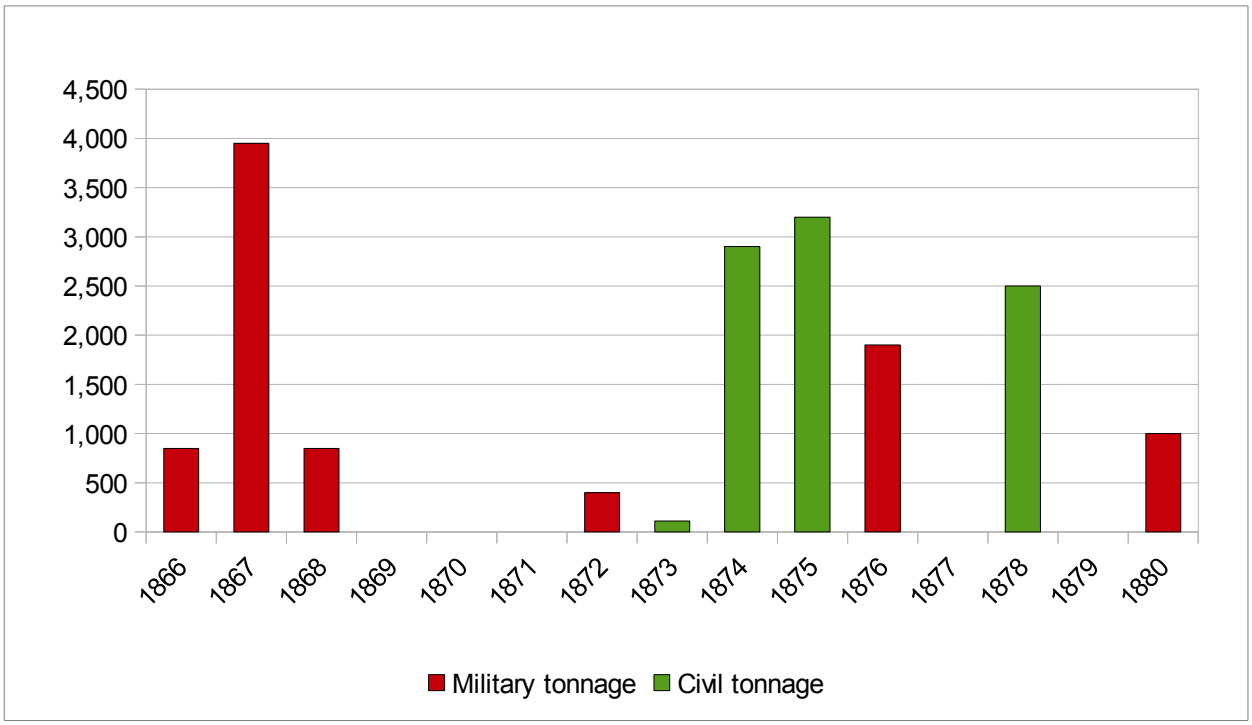
65 On the sales of the yard in Leghorn, Degli Esposti, *Armi Proprie*, 111-12.

66 Camera dei Deputati, *Atti Parlamentari*, *Approvazione del Contratto di Affitto a Favore dell'Ingegnere Luigi Orlando del Cantiere Militare Marittimo di San Rocco in Livorno*, 5.

67 A. Umile, 'Gli Orlando e il Cantiere di Livorno: Considerazioni Intorno a una Vicenda Imprenditoriale tra Iniziativa Privata e Impresa Pubblica', *Rassegna Storica Toscana* 44 (1998), 335-350.

on the year in which ships were launched. This fact underestimates military construction because warships took longer to be built than merchant ships. Consequently, the yard was actually busier than it would appear at a first glance. For example, the battleship *Lepanto* was laid down in 1876, but was launched only in 1883. The peak registered in 1867 represented the launch of the frigate *Conte Verde* which had been started in 1863, before the yard had been leased to Orlando. After this, the yard saw just a few orders coming from the Italian navy which, as it has already been said, moved its construction activities from abroad to its own arsenals. The years between 1869 and 1871-72

Figure 2.8: tonnage of military and civil ships launched at Orlando's Leghorn shipyard, 1866-1880 (in tons).



Source: Gazzo, *Cento Anni*, 585.

were especially bleak: the firm received only one order for a small gunboat in 1869. Starting in the early 1870s the more positive economic trend enjoyed by the Italian economy helped Orlando to secure commercial orders which were essential in keeping the yard in operation. During the same period, the navy awarded Orlando several contracts, the most important of which was for the construction of the despatch vessel *Rapido*, a unit very similar to the *Staffetta* built by Ansaldo, but,

as in the case of Ansaldo, they did not match the peak of the first half of the 1860s.

It was the order for *Lepanto* which moved Orlando's yard to a leading position in naval shipbuilding. This was the first time a contract for the construction of a capital ship was awarded to a private Italian shipyard. If the aim was to speed up the construction of the vessels, this was not achieved: the *Lepanto* entered in service in 1887, eleven years after works had began! The decision to award the contract to a private yard resulted from a combination of different reasons. Certainly there was the desire to help the development of warshipbuilding technical skills and capabilities in the private sectors and it must be remembered that, by mid 1870s, Orlando's yard was the largest yard capable of iron construction in Italy. At this time, the other private yards which subsequently built major Italian warships (Odero and Ansaldo) were smaller. Considering how much Brin worked in the course of the 1880s to reduce the Italian Navy's dependency on foreign imports, and to strengthen the domestic armaments industry, supporting the private shipbuilding industry fitted perfectly into such strategy. In addition the activities of the Navy's yards and arsenals was a controversial topic in parliament, where many MPs were critics of their inefficiency and of the opacity of their administration.[68] Awarding a large contract to a private yard was thus a way to placate critics. However Brin's decision was strongly criticized by the opposition newspapers, which called the vessel the “electoral ironclad”, because Leghorn was Brin's constituency. Thus in 1878 he was forced out of office, where he returned six years later.

The position enjoyed by foreign firms was completely different from that of the Italian companies. Abroad the Italian Navy bought the high quality goods which it was impossible to purchase domestically. An interesting example is that of naval engines. All the first Italian ironclads were equipped with foreign-made engines. There were no Italian firms which could make them. In the course of the 1860s and 1870s, however, orders for naval engines could be divided into two groups. On the one side, there were the engines equipping large vessels which were still purchased from abroad, mainly in Britain. In the course of the 1870s, for example, well-known firms such as John Penn & Sons and Maudslay, Sons & Field built the engines for *Duilio* and for the other battleships.[69] On the other side, national producers secured orders at the other end of the market, that is engines mounted on the small and medium-sized ships, often with a power of less than 1,000 HP. For the Navy it was cheaper to order this kind of engines from Italian firms than to order them

[68] See, for example, the debate generated by the 1875 naval budget, Deputati, *Discussioni*, 2 March 1875.
[69] The list of contracts is in *Inchiesta Parlamentare sulla Marina Mercantile*, 458-459.

abroad. National production progressed in quality over the years, as data on engine production carried on by Ansaldo made evident: in 1862 Ansaldo built a 200 HP engine, in 1863 it received an order for a 600 HP one, in 1865 for a 900 HP one. The progress continued in the 1870s: in 1874 Ansaldo built a 1,400 HP engine, in 1878 a 1,700 HP, in 1880 a 1,500 HP and, in 1881, it received a contract for a 5,000 HP one.[70]

There is no doubt, however that the most crucial component which Italy bought abroad was artillery. As said above, powerful artillery represented a key component of Italian naval strategy, and there was no domestic firm capable of producing it. The Italian Navy purchased from Elswick the ordnance for all its major warships in this period: in 1870 Armstrong signed a contract for supplying 1,559,295 Lire worth of guns, which was followed in 1874 by another, larger, contract (4,553,160 Lire). Additional contracts were later signed for the guns of *Italia* and *Lepanto*.[71] These purchases reinforced Armstrong's position as the leading supplier of large guns for the Italian navy. The reasons why the Italian navy kept purchasing from Elswick were threefold.

First, Elswick was manufacturing exactly what the Italian Navy needed. The case of the guns for the *Duilio* and *Dandolo* is illustrative: the concept behind these vessels was that they had to be able to outgun any enemy ship. As soon as Armstrong was able to design a gun larger than the previous, the Italian government bought it. Elswick was at the forefront of the development of "monster guns", hence the Italian Navy was dependent on it, if it wanted to pursue a strategy based on few, but heavily armed vessels.

While Krupp was also working to design large ordnance – hence representing a potential competitor for Elswick and a possible new source of guns for Italy – there was a second factor which helped to cement the links between Italy and Elswick: technological path dependency. Switching supplier in the armament sector was difficult for a series of reasons. For instance, guns' calibres differed between companies. Continental-wide standardization in armaments appeared only later. Thus swapping supplier would have meant that the stock of shells and projectiles also had to be changed. Deploying alongside guns of similar size, but of different calibres, would have been a logistical nightmare. Moreover gunners were trained to operate specific types of guns. To shift to Krupp would have entailed retraining crews to use a new system of artillery, based on different designs. What is more, to fit different kinds of guns on ships could potentially require significant works to accommodate them on the same turrets. It was much easier to simply stick to just one

[70] Doria, 'Strategie ed evoluzione', 86.
[71] *Inchiesta Parlamentare sulla Marina Mercantile*, 455.

supplier, so far its products were regarded of satisfactory quality.

Finally, personal links between Elswick's management and the Italian military establishment helped to preserve the exclusive connection between the firm and the Italian Navy. Augusto Albini was at the centre of this relationship. In 1872 he was nominated to the position of General Director of the Ordnance and Torpedo, that is he became the head of the office inside the Ministry of Marine which dealt with the purchase of guns. This was a key position from which he could exert much influence on procurement decisions. Albini was totally in favour of Elswick's guns. Armstrong's records preserve many letters and messages exchanged between Albini and the management of the company. The precise nature of the relationship between the naval officers and the British businessmen is unclear: he certainly lobbied in favour of Armstrong from inside the ministry, a position much more effective that the one which any official agent could ever acquire. He also kept Elswick informed of all the last developments of Italian politics and anticipated the details of new contracts.[72] It is not clear, however, if he received monetary compensations from Armstrong, although later on he entered into the firm's management.

While each single factor could not in itself have been decisive, together they represented a significant barrier against replacing Elswick with some other gun manufacturer. Having gained orders from Italy in the early 1860s – thanks to a combination of superior technology and the Italian government's pressing needs for rapid delivery – Elswick retained its leading position as supplier of artillery to the Italian navy for many decades. During the 1860s and 1870s, ordnance technology was rapidly evolving, thus Italy, which could not rely on an indigenous industry, was a keen buyer of Elswick's products.

4.5 *Conclusions.*

Political unification transformed Italy into a European power. The first Italian governments embarked on the construction of a large naval force which was regarded as essential to guarantee national security and prestige. The problem was how to build and equip the new Italian Navy. This task was complicated by the fact that, in the early 1860s, a cluster of technological innovations –

[72] For instance, in 1878, after Brin was forced to resign, Albini had a frank discussion with Noble about how the appointment of a new Ministrer could impact naval construction plans; see T&W, 31/4626. The following year, Albini privately wrote to Rendel to inform him that the State Council had approved a contract for the supply of new artilleries before the news was officially notified to Elswick; see T&W, *Rendel Papers*, 31/4658.

rifled ordnance, wrought iron plates, iron hulled vessels – reshaped naval warfare.

The increased role played by technological know-how put at a disadvantage Italian firms such as Ansaldo, which in the early 1860s had been able to exploit the demands for armaments linked with the Second Independence War. The inability to compete qualitatively with foreign military technology made Italian firms unable to gain orders for the most sophisticated (and profitable) productions such as guns and armour plates. The Italian government, whose paramount preoccupation was that of acquiring the most up-to-date hardware, had no option but to rely on purchases abroad. It is instructive to compare how the relationships between the Italian government and Ansaldo and Armstrong evolved in the course of this period. Ansaldo had been substantially, if irregularly, supported by the Piedmontese government during the 1850s. In the early 1860s, thanks to the demand generated by the Second Independence War and by the creation of the national armed forces, Ansaldo had supplied projectiles, bronze artillery and other military hardware. Ansaldo, however, rapidly declined from being among the most important military suppliers to the Italian Navy to be on the verge of bankruptcy. Armstrong, at the other extreme, became the leading provider of large naval ordnance to the Italian Navy. Armstrong's technological advantage allowed it to sell to a long list of customers and its scale of operations made possible for the firm to undertake the large investments required to manufacture the “monstrous guns” of the 1870s. Ansaldo, by contrast, was unable to reach the “critical mass” required to escalate production. In itself, the absence of orders was the direct consequence of the fact that the firm lacked the technological expertise required to produce advanced military hardware. As a result, Ansaldo ended as a supplier of simple, low technology components. In this context, the ups and downs of military spending put additional pressure on Italian firms which, in addition to foreign companies, had a competitor in the Italian Navy's large network of yards and arsenals.

The increasing sums allocated to military spending from the early 1870s onwards allowed Italian suppliers to improve their positions. However, while Italian firms had learnt to be reasonably competitive in several low-technology niches such as small and medium-sized naval engines and shipbuilding, the Italian Navy still exclusively purchased abroad its most sophisticated and complex hardware.

Chapter III

A Growing Trade: the British Armaments Industry, 1880-1897

This chapter analyses the development of the British armaments industry in the period from the early 1880s to 1897. This period opens with the merger between Armstrong and Charles Mitchell's shipyard – a first example of a combination between an armaments firm and a shipbuilder – and it closes in 1897, before a wave of mergers and acquisitions involving the major armaments firms inaugurated a new phase in the history of the British armaments industry.

During the period covered by this chapter, the British armaments industry changed radically. Three major trends reshaped it. The first was the rise in naval appropriation. The Royal Navy's budget increased by 50% during the 1880s, and doubled during the 1890s. Such an increase resulted from a combination of various factors: the growing costs armaments, recurrent foreign policy-motivated “naval scares” which pushed governments to escalate defence expenditure, and colonial and imperial expansion.

The second trend was a structural change in how the British government allocated its naval budget, from a situation in which resources were chiefly devoted to finance the activities of arsenals and yards, to one in which a significant portion of the budget was spent to buy from private companies. During the 1880s, artillery rapidly evolved, while during the 1890s it was armour plate technology which was revolutionised. These advances favoured private firms able to produce the most up-to-date hardware. While public establishments retained a sizeable share of activity, British governments could not afford to ignore private firms any longer.

The third trend was the growing number of firms operating in the armaments industry. This was a consequence of the increasing business opportunities generated by the expanding naval appropriations. Whereas in the early 1880s, only a handful of companies made military hardware, by the end of the 19th century, the number of firms involved in this sector had substantially increased. The result was that, by the end of the century, the British armaments industry had became larger and more sophisticated than it was twenty years before.

The chapter is organised as follow: the first section analyses the British naval budget in the 1880s and 1890s; the second the technical evolutions which occurred in the same period; the third the development of the British armaments sector and the strategies of the major defence firms.

3.1 *British naval budget, 1880-1897.*

In the last two decades of the 19th century British naval spending grew substantially. Figure 3.1 shows total naval estimates and several sub-total categories.

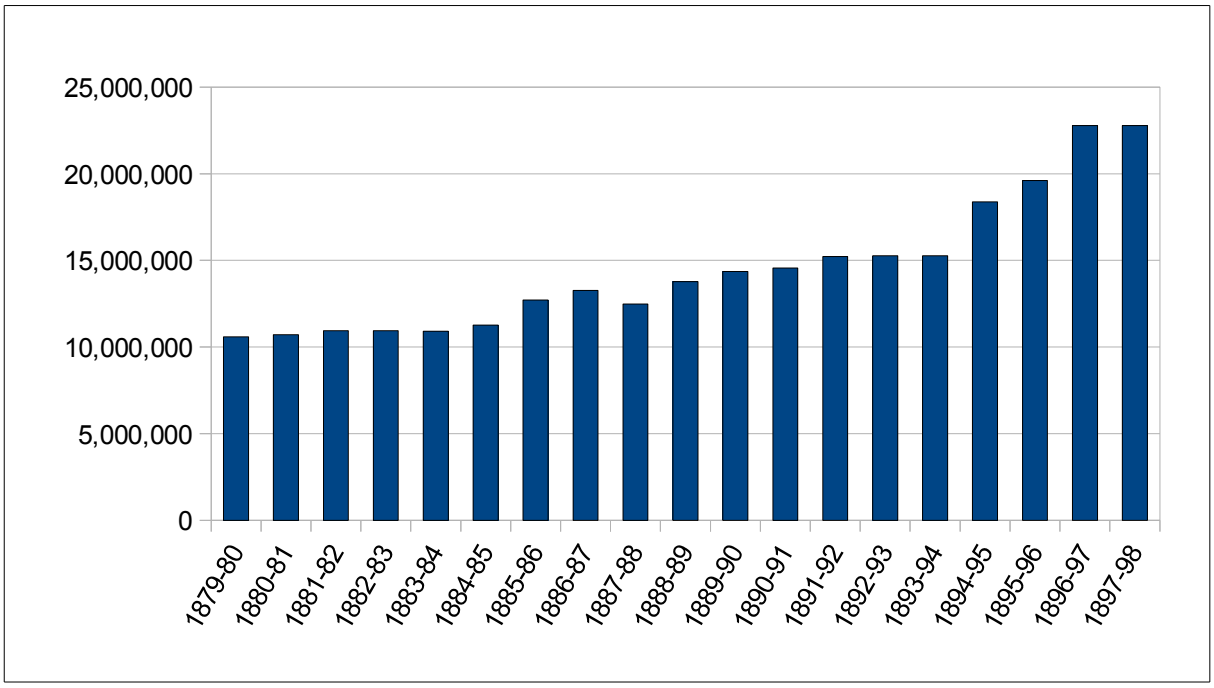
Figure 3.1: British total naval estimates and several sub-total expenditures, 1879-1898 (in current pounds).

Fiscal Year	Total amount of Naval Estimates	Naval Store + personnel (estimated)	Shipbuilding (personnel + materiel)	Contracts	Naval Armaments
1879-80	10,586,894	2,030,000	-	842,000	-
1880-81	10,702,935	2,011,000	-	769,000	-
1881-82	10,945,919	2,172,700	-	683,239	-
1882-83	10,945,919	2,320,000	-	767,153	-
1883-84	10,904,200	2,337,000	-	1,052,600	-
1884-85	11,255770	2,342,000	-	1,040,000	-
1885-86	12,704,900	2,544,500	-	1,962,000	-
1886-87	13,270,100	2,206,000	-	2,371,300	-
1887-88	12,476,800	2,377,000	-	1,911,000	-
1888-89	13,776,572	-	2,772,681	1,514,200	1,863,500
1889-90	14,361,810	-	3,318,900	1,565,000	1,463,500
1890-91	14,557,856	-	3,536,750	1,309,900	1,465,100
1891-92	15,210,620	-	3,865,020	1,300,400	1,595,310
1892-93	15,266,811	-	3,750,812	1,329,000	1,448,700
1893-94	15,267,674	-	3,719,706	1,305,600	1,365,200
1894-95	18,371,713	-	4,326,835	2,959,700	1,433,200
1895-96	19,613,821	-	4,627,995	3,455,640	1,742,711
1896-97	22,774,318	-	4,503,915	5,423,480	2,600,855
1897-98	22,780,473	-	4,195,915	5,248,100	2,709,687

Source: *Navy Estimates*, HCPP, various years.

From 1880 to 1898 naval budgets increased at a considerable but not uniform rate. Until the fiscal year 1884-85, naval estimates remain constant, at £10.5 to £11 million. Between 1884-85 and 1886-87, there was an increase of nearly 30%, to more than £13 million. Naval expenditures remained around this level till the end of the decade (with a small reduction in 1887-88). The first years of the 1890s saw a flat naval budget. Expenditures increased again from 1894-95 onwards, but this time at a higher rate. By 1897-98, naval budget was 49% larger than it had been just five years before. These trends can be gauged looking at figure 3.2.

Figure 3.2: British naval expenditures, 1879-98 (in current pounds).



Source: figure 3.1.

British naval budgets also changed in composition, with more resources devoted to buying from private suppliers. To some extent the activities of the Royal Dockyards and of private firms were complementary, rather than overlapping: government plants never built engines or armour plates, but they carried out the bulk of repairs and maintenance activities.[1] The entries "naval store + personnel" and "shipbuilding (personnel + materiel)" – which from 1888-89 substituted for the first – represented the resources devoted to finance Royal Dockyards' activities. In the period considered here, these resources increased more than three times, from little more than 2 million to more than 6 million. For the period from 1879-80 to 1888-89, naval estimates do not add wages to the amount

1 S. Pollard and P. Robertson, *The British Shipbuilding Industry, 1870-1914* (London, 1962), 213.

spent to purchase stores for “building, repair and outfit of the Fleet”. Wages were included in a different category, together with other expenditures. Therefore, the entry “naval store” has been increased by £1,000,000 each year, an estimation of the Dockyards' total wage bill based on a recalculation of other entries in the estimates. Additional resources devoted to building, repairing and outfitting might possibly be found under other headings, but they are of limited amount and difficult to attribute. Materiel and wages were by far the largest components of the total cost, and therefore their sum provided a good proxy of the amount of resources received by the Royal Dockyards.

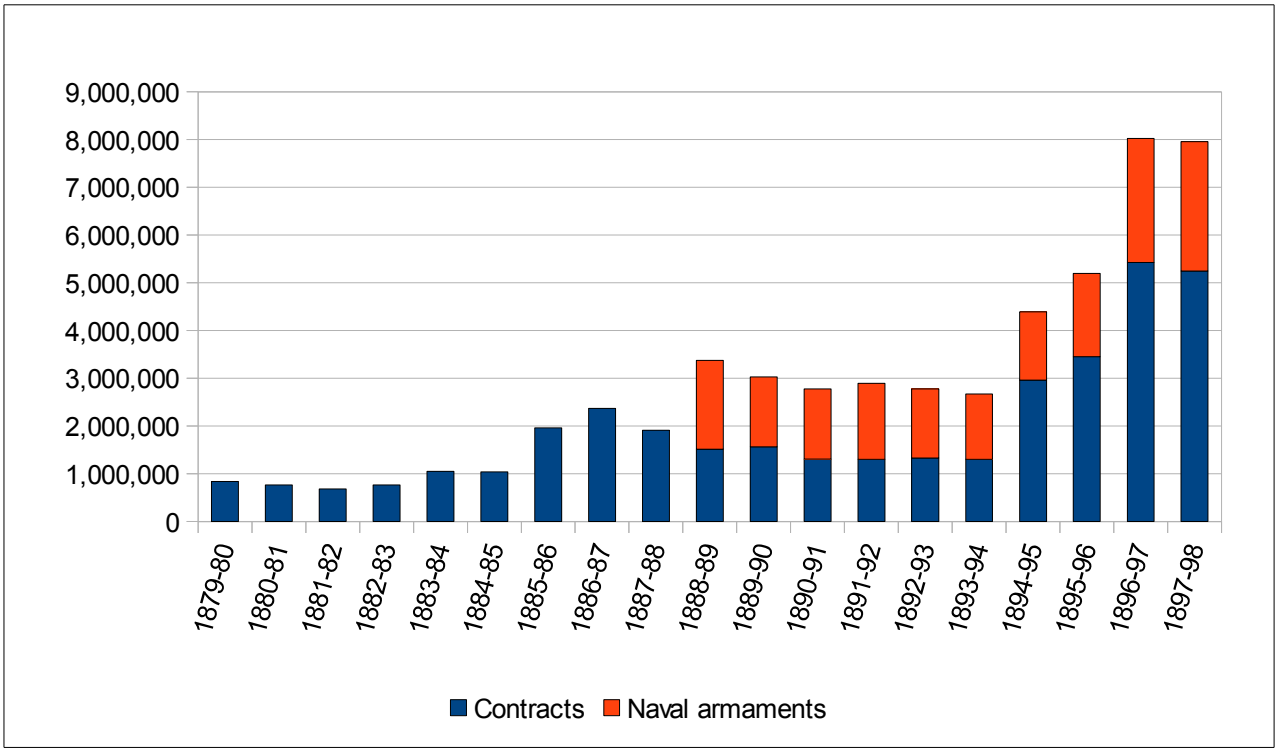
The entry “Contracts” included the costs of warships, engines, and other hardware purchased from private suppliers. Naval estimates offer just a partial breakdown of these expenditures. It is possible, therefore, that a share of these contracts were not relevant to the construction and repair activities of the Navy. But even if the sum was to be reduced by a fifth, for example, the general upward trend would not be altered. From 1888-89 a new entry “Naval armaments” covered sums allocated to buy armaments from private suppliers. Until that year, in fact, the Admiralty did not directly purchase artillery but the War Office supplied it, relying heavily on Woolwich. In 1888 a new Directorate of Naval Ordnance inside the Admiralty took over this duty.[2] The Admiralty, which had little say in the running of Woolwich, favoured from the outset private gun makers. Figure 3.3 shows the trends of contracts and naval armaments, that is resources which were spent to award contracts to private suppliers. It shows how contracts with private suppliers increased both in absolute and relative terms. In 1879-80 they accounted for less than £1,000,000 (7.95% of total naval appropriations); in 1888-89 for more than £3,300,000 (24,5%); in 1897-98 for around £8,000,000 including naval armaments (34,9%). The growth, however, was uneven: there was a short-term rapid increase in the mid-1880s. From 1888-89 additional resources were employed to buy artillery from private makers (on average, £1,500,000 a year), while the value of construction contracts diminished. Large increases of both construction and armaments occurred from 1895-95 to the end of the century.

Figure 3.4 shows the relative weight of dockyard versus contracts expenditures. It highlights how it was at times of naval spending growth (the 1883-87 period and the years after 1893) that the Navy's reliance on private firms increases as they could rapidly add their output to that of the Royal Dockyards. Figure 3.5 presents the relative rate of growth of total naval expenditures, dockyards expenditures, and contracts (including that for naval armaments). Given as 100 the value of each

2 The 1888 reform represented just the first step: in 1891 a Naval Ordnance Department was created to coordinate the supply and custody of artillery components for the Navy. Finally, in 1908, the Navy took over from the War Office also the responsibility of inspecting the quality of ordnance it purchased.

category in 1879-80, in 1896-97 naval spending was 215 (that is, it increased of 215%), dockyards expenditures 222, and contracts and armaments 954 (an increase of more than nine times!).

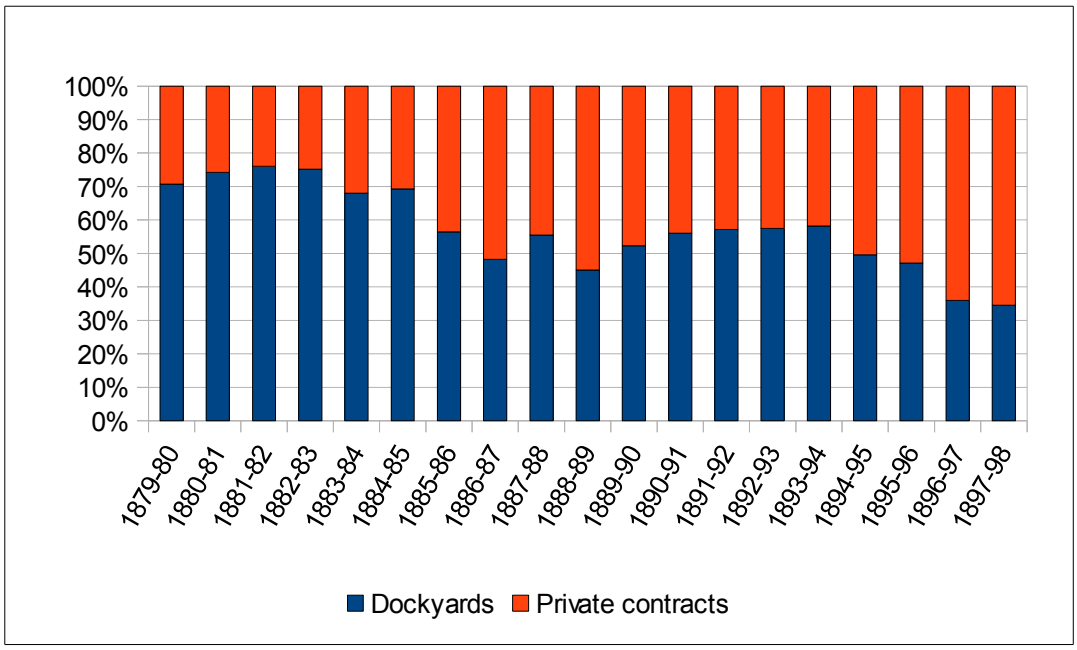
Figure 3.3: naval estimates for contracts and naval armaments, from 1879-80 to 1897-98 (in current pounds).



Source: see figure 3.1.

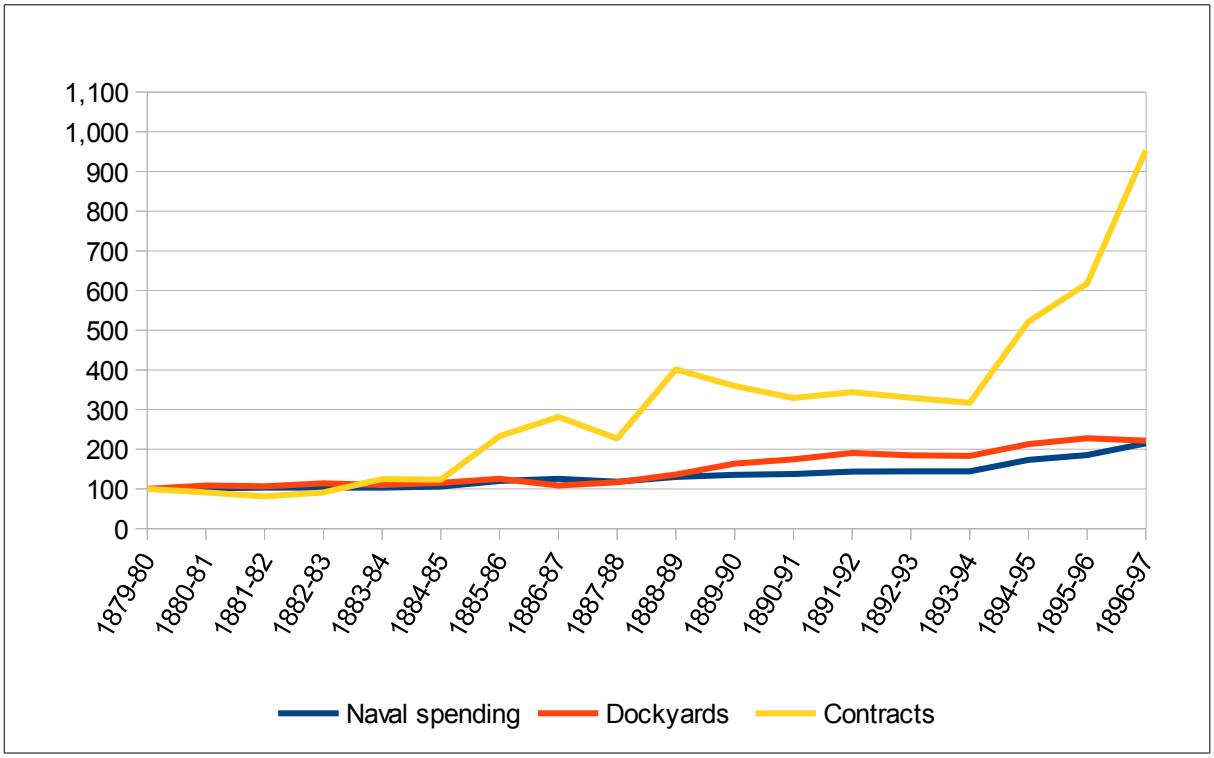
In conclusion, between 1880 and 1897-98, British naval expenditures more than doubled. At the same time, the naval budget composition changed. Whereas in absolute terms all components increased, in relative terms private contracts grew much faster, until, by the end of the century, they absorbed a third of the entire budget. Such a growth was the result of two periods of marked expansion: one in the mid-1880s, and a second, more pronounced, starting in mid-1890s.

Figure 3.4: Relative weight of Dockyards' resources vs. value of contracts for private firms.



Source: see figure 3.1.

Figure 3.5: Relative rate of growth of naval budget, dockyards spending and contracts, 1879-1897 (in current pounds).



Source: see figure 3.1.

Foreign policy considerations determined to a large extent British naval spending. The Royal Navy's aims were to protect Britain from any threat of invasion and to secure the trade between Britain, its colonies and the rest of the world. Any time the Royal Navy was perceived as unable to do so, naval expenditures increased. When British supremacy on the oceans was regarded as safe, expenditures were cut. This had been the pattern since the end of the Napoleonic Wars. For instance, British naval budget jumped from £6,500,000 in the early 1840s to little more than £8,000,000 in 1846-47 because of the threat represented by the expanding American and the French navies. When tensions subsided, naval expenditures were cut to £6,500,000, only to grow again in 1853 to £7,200,000 because of the threat of a French invasion.[3]

What changed in the last years of the 19th century was that the upward trend of naval expenditure was not substantially reversed before 1914. While previously periods of expansion had been followed by periods of decline, in the years from 1884 to 1914, naval expenditures were reduced in absolute values only in five years (the largest reduction year-on-year was of 8.5% in 1905-06). Four factors contributed to this.

The first was technological development. Rapid innovation in many fields of naval technology – propulsion, design, artillery, armour plates, etc. – translated into rapid obsolescence. A functioning battleship immediately lost the majority of its military value if innovations in propulsion made it too slow in comparison with newer vessels. More powerful guns made useless ships armed with older artillery. Rapid obsolescence meant that more resources were required just to preserve the size of the Royal Navy over time.

A second factor were the growing costs of military technology. In these years, warships became larger and faster (and thus more costly). New kinds of vessels, such as destroyers, were devised and built. More sophisticated armour plates and long-range guns were introduced. Indirect costs added to the burden: larger docks, the recruitment of additional seamen, etc. As a result, warships did not just have a shorter operational life, but they became more expensive to replace and maintain.

A third trend was that more governments started to pursue expansionary naval policies. In the 1860s and 1870s, only Britain, France and, to a lesser extent, Russia and Italy, financed significant construction programs. But in the last two decades of the 1800s, Japan, the USA, and Russia all adopted “strong navy” policies. In addition to the main powers, regional ones such as Spain, Austria-Hungary, China, Brazil and Chile invested to modernise and expand their fleets. Enthusiasm for naval affairs – testified by the creation of Naval Leagues in many countries – and

3 W. L. Clowes, *The Royal Navy: A History from the Earliest Times to 1900*, vol. 6 (London, 1997), 191; F. Beller, *British Naval Policy in the Gladstone-Disraeli Era, 1866-1880* (Stanford, 1997), 58.

the popularisation of Captain Alfred T. Mahan's ideas on sea power helped to create the momentum for naval expansion.[4] Whatever the contingent diplomatic realities, Britain had to spend more to preserve the dominant position of the Royal Navy.

A fourth factor was the enlarging of the British overseas empire and the reliance of the British economy on international trade. For example, Britain depended on imported foodstuff, as British agriculture was in relative decline.[5] The country's free trade policy needed a strong navy to maintain open and secure trade routes connecting the British islands with the rest of the world.

These structural factors started to operate in the course of the 1880s and they influenced British naval policies until over 1914. While they explain why naval spending grew, some specific events had an impact on the temporal dynamics and allocation of naval budgets. Three political decisions were crucial: the Northbrook programme (1884), the Naval Defence Act (1889) and the Spencer Programme (1894).

During the 1860s and 1870s British political life had been dominated by issues other than naval affairs (e.g. social and electoral reforms, Irish Home rule). The Franco–Prussian War added pressure to reform the Army, rather than increasing interest in the Navy. This resulted in the Cardwell Reforms which modernised the Army's administration and created a more professional War Office.[6] The Navy, in contrary, was largely ignored.[7] In early 1880s, however, occurred a change. Disagreements with both Russia and France led to the possibility that they could combine their fleets against Britain. This was a serious threat because in the 1870s both countries had invested to enlarge their navies.[8] The real capacity of the Royal Navy to protect Britain became reason for public anxiety.

In September 1884 the *Pall Mall Gazette* ran a series of articles on the Royal Navy written by W. T. Stead, editor of the newspaper, under the pseudonym of "One Who Knows".[9] The articles stated that Britain and its interests around the world were in danger.[10] The Royal Navy, because of insufficient expenditures, was not able to protect them any longer. In contrary, France and Russia were investing to modernize their fleets, and their combined strength could prove too much for the Royal Navy. Thanks to a display of data and information which several naval officers dissatisfied

4 H. Herwig, 'The battlefleet revolution, 1885-1914', M. Knox and W. Murray (eds.), *The Dynamics of Military Revolution, 1300-2050* (Cambridge, 2001), 119

5 A point illustrated by A. Offer, *The First World War: An Agrarian Interpretation* (Oxford, 1989).

6 A. V. Tucker, 'Army and Society in England 1870-1900: A Reassessment of the Cardwell Reforms', *Journal of British Studies* 2 (1963), 110-141.

7 M. J. Bastable, *Arms and the State. Sir William Armstrong and the Remaking of British Naval Power, 1854-1914* (Aldershot, 2004), 204.

8 L. Sondhaus, *Naval Warfare, 1815-1914* (London, 2001), 114-119 and 122-126.

9 J. O. Baylen, 'Stead, William Thomas', *ODNB*.

10 A point also made in 1879 by the *Royal Commission on the Defence of the British Possession and Commerce Abroad*, whose conclusions, however, were not divulged.

by what they regarded as a limited commitment of the Liberal government toward the Navy had supplied him with (among them there was Captain John Fisher, who played a crucial role inside the Royal Navy in the two decades before 1914), Stead presented these ideas in a convincing way.[11]

The issue was seized upon by the Conservative party, which campaigned in favour of rearmament. Business circles started to lobby for increasing naval spending with the hope of receiving orders.[12] Armstrong, speaking at the shareholders' meeting of his company, described the worries about the state of the Royal Navy as being "well founded".[13] Political agitation continued until Gladstone, who had opposed any increase in armaments spending, relented: in 1885 the government authorized the Northbrook programme which appropriated an additional £3,100,000 to built two battleships, seven cruisers, and tens of torpedo boats.[14] Both new battleships were ordered from private yards, HMS *Victoria* from Elswick (the first battleship with triple expansion engines entering service in the Royal Navy) and HMS *Sans Pareil* from Thames Ironworks. They were armed with guns made by Armstrong. At the same time, five of the seven new cruisers were ordered from private yards, while two were built by the Royal Dockyards.

The sudden increase in demand could not be met in the short-term by government plants. For the first time, a significant share of orders was given to private yards, whose output was required to rapidly complete the programme. Despite the fact that the Northbrook programme was modest in comparison with the ones which followed, it represented an important step toward a growing role for British armaments firms in the supply of the Royal Navy, a role which, until then, had been, with the exception of armour makers, limited and sporadic.

During the late 1880s, the Royal Dockyards were thoroughly reorganised under the supervision of George Hamilton.[15] Such improvements temporarily limited the need to rely on private yards. Private yards built just 26% of the total tonnage authorised for the Royal Navy in the period 1884-89.[16] In the same years the absence of serious disagreements with continental powers reduced the need to enlarge the Royal Navy. Therefore, naval expenditures remained on the same level as in the 1880s and in 1887-88 were actually cut by around 6%. In 1887 Britain did not lay down any new battleship.

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11 S. R. B. Smith 'Public Opinion, the Navy and the City of London: the Drive for British Naval Expansion in the late Nineteenth Century', *War and Society* 9 (1991), 29-50.

12 See, for instance, the letter which Vickers, Cammell and Firth jointly sent to the chairman of the Parliamentary Committee on Army Estimates complaining that the government had not awarded the orders they had been expecting since 1884, see HCPP, letter dated 9 August 1888.

13 *The Times* 2 October 1884, 2.

14 E. J. Grove, *The Royal Navy since 1815* (New York, 2005), 71.

15 On Hamilton's reforms see D. K. Brown, *A Century of Naval Construction: the History of the Royal Corps of Naval Constructors, 1883-1993* (London, 1993), 62-64; Pollard and Robertson, *Shipbuilding*, 205-211; and J. Hass, *A Management Odyssey: the Royal Dockyards, 1714-1914* (London, 1994), 147-167.

16 *Conway's All the World's Fighting Ships, 1860-1905* (London, 1997), *passim*.

In 1888 a new "naval scare" erupted: the French fleet had gathered in the Mediterranean, something which was regarded as a potential threat in both Italy and Britain. Despite the Admiralty being confident about its ability to defend the country's interests in the Mediterranean, there was political agitation to reverse the reduction in naval expenditures of the previous year.[17] The result was the adoption in 1889 of the Naval Defence Act which authorised additional expenditures worth £21,500,000 over the next five years for the construction of 10 battleships, 42 cruisers and 18 torpedo boats. Half of the money was to be spent on four battleships and twenty-two cruisers ordered from private yards.[18] Once again, a sudden increase in the demand for vessels (and the consequent increase of the demand for guns, armour, etc.) could not be fully met by the government establishments. Private firms then played a decisive role in supplying vessels and armaments. Several new firms decided to venture into the armaments sector to exploit this opportunity.

The "two power standard" was formulated in the context of the debate on the 1889 Naval Defence Act. in March 1889 Hamilton stated in the Commons that "the leading idea has been that our establishment should be on such a scale that it should at least be equal to the naval strength of any two other countries."[19] While the "two power standard" was never sanctioned as an official policy, it was informally upheld. The arithmetic of the "standard" pushed subsequent governments to answer any foreign construction programme with increases in British naval appropriations.

At the beginning of the 1890s, the British naval budget was around £15,000,000, 50% more than ten years before. In the course of the 1890s, expenditure doubled. The growth was especially strong in the period 1894-1900. The Naval Defence Act did not restrain France and Russia from trying to match the British efforts.[20] Britain responded by adopting the Spencer Programme in December 1893. This new programme allocated £31,000,000 for a new five-year naval construction plan at whose core there were seven (later increased to nine) battleships of the new *Majestic* class. Reflecting the sense of urgency, all the nine vessels were laid down within fifteen months from when the Bill was passed.[21] The difference between the various construction programmes was that, while after the Northbrook programme and the 1889 Naval Defence Act, military expenditures had been stable for a few years, after the Spencer programme expenditures kept growing, a trend which was not broken until mid-1900s.

17 Grove, *Royal Navy*, 75.
18 J. T. Sumida, *In Defence of Naval Supremacy: Finance, Technology, and British Naval Policy, 1889-1914* (Boston, 1989), 13.
19 Hansard, 7 March 1893, col. 1171
20 Sondhaus, *Naval Warfare*, 166-168.
21 L. Soundhaus, *Navies in Modern World History* (London, 2004), 18.

3.2 *Technological evolution*.

During the 1880s and 1890s artillery, armour plates, torpedoes, and naval design all improved. Competition between ordnance and armour, and between torpedo and guns, influenced how ships were built and naval strategy. The majority of the innovations in ordnance and naval architecture occurred during the 1880s. The evolution of armour plates, at the opposite, was especially rapid during the 1890s.

Three major innovations occurred in ordnance: the introduction of breech-loading steel-made guns; improvements in the composition of explosives; and the development of quick-firing small calibre guns. In the 1870s naval artillery evolved in size but the basic muzzle-loading design remained unchanged. Breech loading, however, enjoyed a clear theoretical superiority. In 1872 Charles de Bange, a French artillery officer, devised a breech closing mechanisms based on an interrupted screw which, with little modification, is still used nowadays. In Britain the return to breech-loading was accelerated by an accident which happened in 1879 on HMS *Thunderer*: a 12 in. muzzle-loading gun exploded killing eleven seamen and injuring many others after it was mistakenly double loaded.[22] As *The Times* remarked, such a mistake "could not by any possibility have happened if the gun had been a breech-loader."[23]

A second innovation favouring breech-loading guns was the adoption of a new slow burning explosives.[24] To exploit the advantages of slow burning explosives, however, the length of the barrel had to be at least 30 times its calibre, to give room to the explosive to burn.[25] This made it difficult to use slow burning explosives with muzzle-loading guns: the required length of the barrel would have made cumbersome charging the gun from the muzzle. Brown powders – a group of explosives with similar compositions – were the first slow burning explosives to be developed. They were introduced in the late 1870s, and by the early 1880s it was widely adopted by navies around the world.[26] The slower rate (in comparison with traditional black powder) at which they burned was obtained by substituting charcoal with less reactive substances and by manufacturing it in larger grains. The use of slow burning powder led to higher muzzle velocities (the velocity at which projectiles leave the barrel: the higher it is, the more accurate and flat the trajectory) which jumped

22 A description of the accident and of the subsequent investigations is in T. Brassey, *The British Navy: Its Strength, Resources, and Administration*, vol. 2 (London, 1882), 81-87.
23 *The Times* 31 March 1879, 9.
24 I. V. Hogg and J. Batchelor, *Naval Gun* (Poole, 1978), 78.
25 J. Campbell, 'Naval Armaments and Armour', R. Gardiner (ed.), *Steam, Steel and Shellfire: The Steam Warship 1815–1905* (London, 1992), 161.
26 R. Parkinson, *The Late Victorian Navy: the Pre-dreadnought Era and the Origins of the First World War* (Woodbridge, 2008), 135.

from 1,500-1,600 to 2,000-2,200 feet per second.[27] Guns were redesigned to adapt to slow-burning explosives: longer barrels were introduced, while the thickness of the breech was reduced, because the violence of the explosion was no longer concentrated there.

In mid 1880s, brown powders were replaced by nitrocellulose-based smokeless explosives. While burning, brown powders generated plenty of smoke which reduced visibility, making protracted engagements possible only at short distances. Smokeless propellants provided the solution. Several propellants were developed before 1914, all based on nitrocellulose, also know as guncotton.[28] Nitrocellulose had been known for decades, after its invention in the late 1840s, but the first nitrocellulose-based compounds were too unstable: nitrocellulose could be used in mines and torpedo warheads, but not in firearms.[29] The first smokeless explosive suitable for firearms was "Poudre B", invented in 1884 by the French chemist Paul Vieille. French armed forces swiftly adopted it, even though it was still relatively unstable (a problem which persisted until the early 1910s).[30] Other countries followed France by adopting one of the various types of nitrocellulose-based compound which were patented in those years. For example, the Italian Army employed "ballistite", invented by Alfred Nobel, while the British armed forces adopted cordite, developed by Frederick Abel, the chief chemist of the War Office, after a government committee headed by the same Abel had rejected all other alternatives.[31] Cordite offered a remarkable improvement in range – which passed from 2,000 to 4,000 meters – and weight – because of its higher heat content 40 kg of cordite produced the same muzzle velocity from a 12 in. gun of 130 kg of brown powder.[32]

The third factor which facilitated the reintroduction of breech-loading guns was the increasing availability of high-quality steel. In the late 1850s Armstrong had built prototypes using a steel barrel encapsulated in wrought iron hoops. Armstrong, however, ditched steel because he was sceptic about the possibility to produce highly homogeneous steel. During the 1870s, however, the introduction of the Martin-Siemems and Gilchrist-Thomas methods allowed the production of large and homogeneous forgings which could be used for gun making.

The new explosives made breech-loading guns more powerful than comparable muzzle-loading artillery. Very large calibre guns – such as the Woolwich 16 in. or Armstrong 17.72 in. –

27 P. Hodges, *The Big Gun. Battleship Main Armament, 1860-1945* (London, 1981), 28.
28 This paragraph is based on T. L. Davis, *The Chemistry of Powder and Explosives*, vol. 2 (New York, 1943), chapter 6 'Smokeless Powder'.
29 The explosives properties of guncotton impressed Jules Verne who used it to launch a projectile in space in his novel *From the Earth to the Moon*, published in 1865.
30 R. Walser, *France's Search for a Battle Fleet: Naval Policy and Naval Power 1898-1914* (New York, 1992), 153-154.
31 Nobel sued Abel accusing him of patent infringement, but lost his case, R. Steele, 'Abel, Sir Frederick Augustus', *ODNB*.
32 P. Padfield, *Guns at Sea* (New York, 1974), 194-195.

were discontinued in favour of smaller calibre which could, however, engage the enemy at longer distances with a higher rate of fire. 12 in. guns became the main naval armaments: it remained the standard on all the battleships from the early 1880s to the early 1910s (only Germany adopted the slightly smaller 11.1 in. calibre). Over time, however, while the calibre remained the same, barrels grew longer. In the early 1880s, the barrel of a 12 in. gun was 25 times the length of its calibre; by 1895, 35 times; by 1900 40 times.

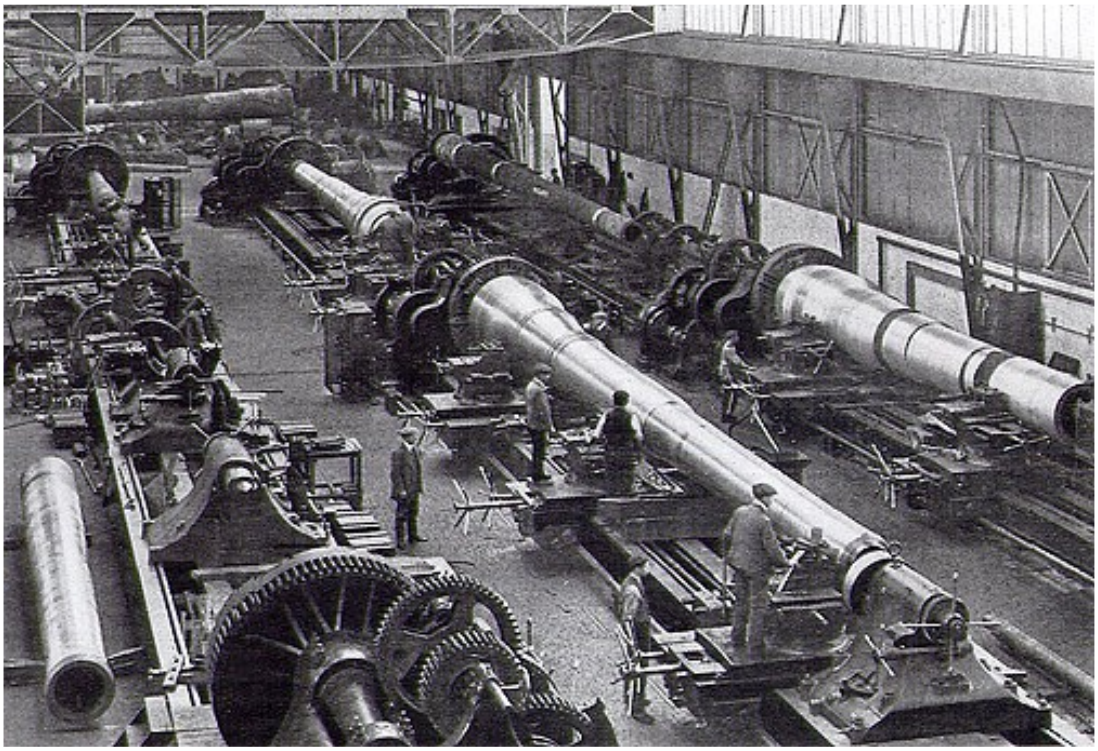
After the replacement of muzzle-loading with breech-loading guns, ordnance evolved with small, incremental improvements. The only major innovation was the introduction of wire-wound guns. In these guns the internal hoops were replaced by steel wire tightly wound around the barrel so to increased the radial strength of the gun. At the same time, however, wire-wound guns were slightly more prone to droop and loose their alignment. Wire construction was not universally adopted: only the British and the Japanese Navy (which bought guns in Britain) widely used them.[33]

These radical improvements in artillery had an impact on gun making, which became more complex. The best way to understand how elaborate, capital-intensive, and time-consuming this process was, is to describe how naval guns were made.[34] The first step was to cast a steel solid ingot and let it cool, something which required four or five days. Then the ingot was trepanned and subsequently reheated and forged by a hydraulic press (forging was used to give additional strength to the metal). After this, lathes were use to rough-turn the exterior. Boring the ingot was the next. Special horizontal boring machines were used for the longer barrels. At this point, the piece was heated again and immersed in oil to strengthen it. After that, metal samples where taken to be analysed. If the material had the required characteristics, the process continued. The next step was wire winding. For a 12 in. gun 117 miles of wire were used. After this, lathes were employed to smooth the external surface in preparation of the shrinking of steel hoops around the barrel. Hoops were expanded by warming them, then they were forced around the wire-wound tube. After the metal cooled down, the barrel was rifled by special cutting machines. This was one of the most difficult moments of the manufacturing process, because the rifling had to be carried out with extreme precision. Finally, the breech mechanism, whose manufacture was in itself complicated, was attached to the barrel. At this point the gun could be tested. The manufacture of a large gun – 9.4, 10 and 12 in. – took up to 10 months.

33 O. F. G. Hogg, *Artillery, its Origins, Heyday and Decline* (London, 1970), 91-92.

34 This description is based on A. Richardson, *Vickers Son and Maxim Limited: their Works and Manufacturers* (London, 1902), 55-70, a special issue of the journal *Engineering* entirely devoted to Vickers's.

Figure 3.6: lathing of barrels of large calibre guns, circa 1902.



Source: Wikimedia Commons.

Improvement in ordnance had an impact on armour plates' development. In the late 1870s compound armour replaced wrought iron plates, proving to be cheaper and of better quality that the first all-steel plates. In the 1880s new systems were devised to enhance armours' resistance. For example, chilling the heated surface of plates using high-pressures jets of water improved their strength (the so called Tressider method). In 1889 Schneider introduced nickel-steel plates. They were a noticeable advancement over all-steel armours: nickel increased the strength while reducing the metal's brittleness. With the same aim, oil quenching – the immersion of the heated surfaces of plates in oil for a short period of time – was simultaneously introduced. Trials in the USA and Russia demonstrated the superiority of nickel-steel over compound plates.[35]

In 1890 the American engineer H. A. Harvey devised a new process to harden steel plates. Plate were heated at 1,100° for three weeks with one face put in contact with finely divided charcoal. By osmosis, carbon particles penetrated the metal altering the chemical composition of the superface. The plate was then tempered by oil quenching, while additional steps – re-forging, water

35 W. Johnson, 'Some Conspicuous Aspects of the Century of Rapid Change in Battleship Armours, c. 1845-1945', *International Journal of Impact Engineering* 7 (1988), 271.

chilling, etc. – were later added to enhance performances. The Harvey process produced plates which were 50% more resistant than steel plates, and 20% than nickel-steel ones.[36] Harvey plates were rapidly adopted by all the major navies in the world given their "astonishing success" in trials.[37]

In mid-1890s Krupp devised a system to produce plates 15% stronger than "harveyized" ones.[38]. Building on years of investigations, Krupp found that a 4% nickel steel alloy to which 2% of chromium was added offered the best starting material. Plates were then hardened using a process similar to Harvey's but charcoal was substituted by hydrocarbon gas, which allowed better control of the reaction. From mid 1890s to the First World War there were no breakthroughs in armour making, only small incremental improvements slightly altering the alloy composition and the production process. In two decades armour making had changed beyond recognition. Plates also became larger and thus more complex to produce. In the late 1880s armour plates measured in average: 1800x1000x150 mm, in the late 1890s 2440x18830x267 mm.[39] The manufacturing process had moved from being a relatively straightforward one of forging and rolling iron bars to a sophisticated, time-consuming, activity based on a deep understanding of the chemical properties of metals and other materials.

While armour was designed to withstand hits from artillery, warships faced another threat: torpedoes. The first self propelled torpedo was designed in the early 1860s by the British engineer Robert Whitehead while working in Fiume.[40] Whitehead soon established a company to manufacture his invention. The new device attracted much attention: even though it suffered from short range (below 1,000 meters) slow velocity (less than 10 nodes), poor stability and limited explosive load, all major navies rushed to purchase it.[41] To deliver them special torpedo boats were developed: small ships which used their fast speed to arrive close to larger warships and then strike them with a salvo of torpedoes. France and Russia, always looking for a cheap way to counterbalance British numerical superiority in capital vessels, demonstrated special interest for torpedo boats.

A group of French naval thinkers known as the *Jeune École* advocated the idea of giving up ironclads altogether in favour of torpedo boats and fast cruisers which they regarded as the most

36 Id., 273-274.
37 *The Times* 2 November 1892, 11.
38 Johnson, 'Aspects', 274.
39 G. Papuli, 'Processi, Prodotti e Immagini', Renato Covino and Gino Papuli (eds.), *Le Acciaierie di Terni (*Milano,1998), 35.
40 E. Gray, *The Devil's Device: Robert Whitehead and the History of the Torpedo* (Annapolis, 1991), 19.
41 A. Casali e M. Cattaruzza, *Sotto i Mari del Mondo. La Whitehead 1875-1990* (Roma-Bari, 1990); Whitehead is now part of the Finmeccanica group as WASS – Whitehead Alenia Sistemi Subacquei.

effective way to confront Britain: torpedoes would sink ironclads, while cruisers would raid British commerce, cutting Britain from its empire and starving the country. The cheapness of the solution was especially alluring for a country such as France which had also to maintain a large army. In the course of the 1880s the *Jeune École* gained control over French naval policy, and between 1883 and 1887, France did not lay down any ironclad, but just cruisers and torpedo boats.[42] Only at the end of the decade, after improved anti-torpedo armaments weakened the *Jeune École* strategy, the French Navy returned to a more traditional approach based on battleships.

Figure 3.7: Drawing of the internal mechanism of a Whitehead torpedo, from the French popular science journal *La Nature*, December 1891.

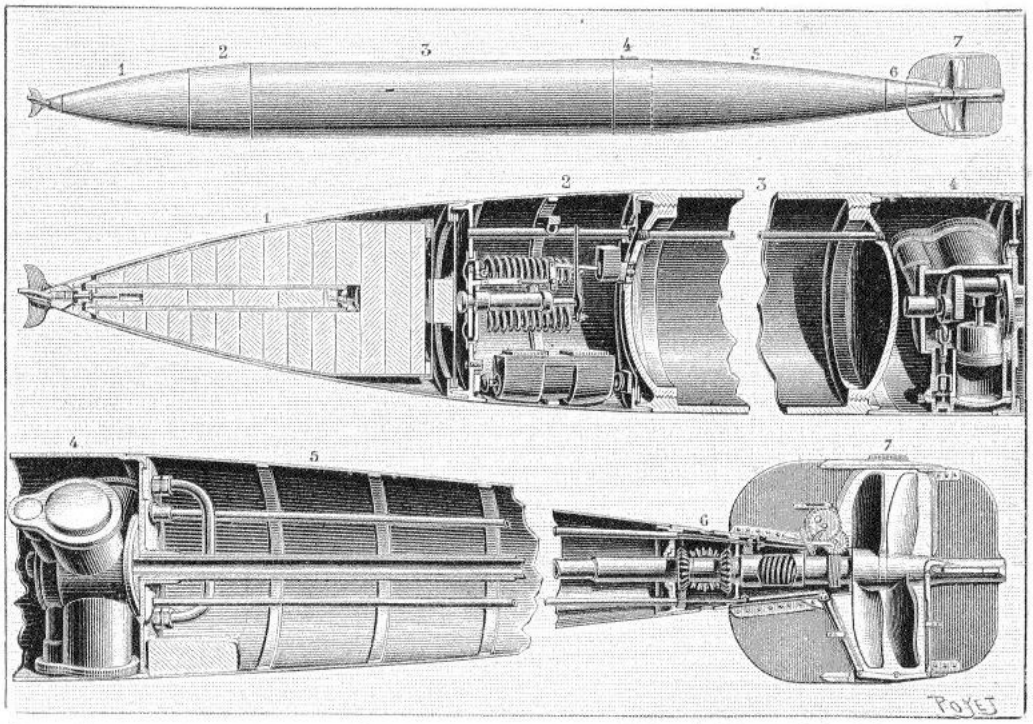


Fig. 1. — Torpille automobile Whitehead. — 1. Magasin. — 2. Chambre à secret. — 3. Réservoir d'air comprimé. — 4. Chambre des moteurs à air comprimé. — 5. Flotteur ou chambre de flottaison. — 6. Mécanisme de commande de rotation des hélices. — 7. Hélices et gouvernails.

Source: Wikimedia Commons

Quick-firing artillery was developed in the late 1880s as a response to torpedo boats. Large guns were not manoeuvrable enough to be used against fast moving targets, and they lacked the higher rate of fire required to engage large number targets. Quick-firing guns, at the opposite, were highly manoeuvrable and achieved a high rate of fire: during a trial in Elswick in 1887, a 4.7 in.

42 A. Røksund, *The Jeune École. The Strategy of the Weak* (Leiden, 2007), 1-84.

quick-firing gun fired ten times in 47.5 seconds.[43] Three features allowed this: the use of cartridges containing both shell and propellant (which in large guns were separated to facilitate loading); a breech-closing mechanism allowing a rapid reloading (the blocking mechanism was designed to be swung round to the side before it was fully withdrawn, rather than having to be fully withdrawn before swinging);[44] a mounting which, thanks to buffers, allowed the barrel to rapidly return to the same position it had before firing. Since 1889, 4.7 in., and later 6 in., quick-firing guns started to be mounted as anti-torpedo armaments on all British battleships. Quick-firing artillery rapidly became a standard component of warships' armaments: while it did not penetrate thick armour plates, it damaged superstructures, hit seamen and was highly effective against torpedo boats.

Naval design was the last area where major innovations occurred. The first change was the substitution of iron with steel as a construction material. Steel was lighter and more resistant. Using it made possible the reduction in the weight of a ship while increasing the space left for machinery and cargo. Until the late 1870s, however, steel suffered from two limitations: it was difficult producing the large castings required for shipbuilding, and it was more expensive than iron: "from 1859 to 1875 steel plates and angles [used in shipbuulding] were generally some 75 to 100% above the price of the corresponding iron products".[45] The widespread adoption of Bessemer converters, the Thomas process, and Martin-Siemens open-hearth furnaces solved these problems.[46] By 1890 the total displacement of steel ships was near twenty times that of iron ships.[47] The Royal Navy ordered its first steel vessels in 1875-76 and by the end of the decade steel became standard construction material.

This change was accompanied by improvements in the design of engines and boilers which raised efficiency and speed. As a result, by the early 1880s ironclads which operated in foreign stations where coaling could be difficult started to be constructed without masts and rigs.[48] During the 1880s, however, as in the previous two decades, there was remarkable inconsistency in naval architecture. In a period of rapid technological change and strategic uncertainty, it was difficult to find a satisfactory balance between the number of guns, the thickness of armour, and seagoing performance.[49] Limited naval budgets restrained construction activities to single vessels which were introduced one after the other, each designed under peculiar economic, technical and political

43 Campbell, 'Naval armaments', 163.
44 I. V. Hogg and L. F. Thurston, *British Artillery Weapons and Ammunition, 1914–1918* (London, 1972), 35.
45 J. C. Carr and W. Taplin, *History of the British Steel Industry* (Oxford, 1962), 110.
46 H. R. Schubert, 'The Steel Industry', C. Singer (ed.), *A History of Technology*, vol. 5, *The Late Nineteenth Century c. 1850 to c. 1900* (Oxford, 1958), 57-60.
47 D. Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present* (Cambridge, 1969), 260.
48 J. Beeler, *Birth of the Battleship. British Capital Ship Design* (London, 2001), 53-64.
49 J. Roberts, 'Warships of steel 1879-1889', Gardiner (ed.), *Steam*, 95.

circumstances, rather than making possible the construction of classes of uniform vessels. By mid decade, the difficulty in opposing torpedoes seemed to prove the *Jeune École* right: battleships were in danger of becoming relics of the past.

The combination of improved ordnance, better but lighter armour and quick-firing guns, however, provided a successful mix which led to what has been labelled the "rebirth of the battleship". Technological developments reduced the risks from torpedoes and improved warships' performances in every field. From the late 1880s, battleships re-acquired a central position in naval strategy – and governments' budgets – which lasted unchallenged until 1914. At the core of the 1889 Naval Defence Act, for example, there were the eight *Royal Sovereign* battleships. Moreover, Alfred Mahan's books on sea power in history offered arguments in favour of the adoption of naval doctrines based on battleships: according to the proponents of this "deep water strategy", a maritime power's goal was that of acquiring naval superiority in high seas. For that torpedo boats and other small vessels were useless. Only battleships could gain the command of the seas.

After three decades of lack of uniformity, during the 1890s naval design largely stabilised. This process started with the *Royal Sovereign* battleships. These vessels were the first to display several features – four major guns deployed in two centreline turrets fore and aft, a combination of various small and medium calibre guns, triple expansion engines, high freeboard which allowed oceanic operations – which later characterised all warships built around the world in the period 1890-1905 (the so called "pre-dreadnought" design).[50] Battleships built during the 1890s were on average bigger (displacing 11,000-16,000 tons versus 6,000-12,000), longer (130-105 meters versus 120-85) and faster (17-18 knots versus 15-16) than the ones of the 1880s. The same occurred also for first class cruisers (10,000-14,000 tons versus 8,000-6,000), and for all other classes of vessels.

Larger naval budgets helped navies to plan future construction programmes more carefully. As a result, instead of single vessels, classes of battleships with very similar specifications were introduced.[51] Uniformity facilitated operations because all vessels had very similar characteristics and performances. At the same time, uniformity of design facilitated increases in productivity, economies of scale, and shorter construction times. While British ironclads laid down during the 1880s required in average 7 years to be completed (and in other countries it took longer), pre-dreadnought usually entered service after half that time.

50 Sondhaus, *Naval Warfare*, 160.

51 R. Burr, *British Battleships, 1889-1904* (Annapolis, 1988) provides detailed descriptions of each class of British pre-dreadnoughts enriched by numerous photographs.

3.3 *The evolution of the British private armaments industry.*

This section analyses the development of the British armaments industry from 1880 to the late 1890s. At the beginning of this period, only a few firms were involved in the armaments industry: Armstrong, which sold principally abroad; John Brown and Cammell, which monopolised armour plate manufacturing; and a group of shipbuilding firms which sporadically received orders for warships. In addition John Brown, Cammell, and Vickers supplied Armstrong and Woolwich with the iron and steel forgings required for gun making.

Twenty years later, the British armaments industry had changed considerably. Three major developments occurred. First, the number of firms involved in armament production increased. Second, armaments firms became bigger, employing more workers, and enlarging their activities. Third, the relationship between the British government and a group of armaments firms moved from being sporadic, to become more systematic. These transformations were the results of the interaction between two factors. First, the ballooning naval budget. The sudden increase in defence expenditure stimulated new firms to enter the armaments sector. The fact that the upward trend in naval spending was not reversed – although there were periods of stagnation – allowed firms to undertake the investment required to carry out military production. Second, technological innovations favoured larger production units. This was in itself the result of various factors: search for scale economies, increasing physical size of ordnance and vessels, more complex manufacturing processes.

By the end of the 1890s, the British armaments industry was composed of more firms, but it was still relatively fragmented. Not all firms produced the same hardware, or were involved in armaments production in the same degree. Thus firms can be classified using two criteria: the relative importance of military production, and the nature of their military output (figure 3.8). By the late 1890s military production represented the core activity only for Armstrong. For Cammell, John Brown and Vickers military and civilian productions were equally important. Finally there were shipbuilding firms whose major activity was merchant construction, but which received contracts for warships from both the British and foreign governments. At the same time, figure 3.8 highlights the fragmentation of the British armaments industry. The number of firms were active in each field was low, especially in the most complex ones such as gun making or amour plates. More firms, by contrast, were active in shipbuilding which was easier and required less capital investments. The level of integration was also still limited (only Armstrong and Vickers were active

Figure 3.8: British armaments industry in the late 1890s.

Relative importance of armaments production

Productions	High	Medium	Small
Ordnance	Armstrong	Vickers	
Armour plates		John Brown Cammell Vickers	
Naval shipbuilding	Armstrong		Several shipbuilding firms

in more than one field). It was only from 1897 onwards that a wave of amalgamations created a higher degree of integration.

The number of firms in the industry makes it difficult to detail the activities of all of them; instead four representative cases are analysed: John Brown and Cammell (jointly), Armstrong, Vickers, and the Clyde-based cluster of shipbuilding firms. Together, they highlight the different patterns of growth and development, the strategies and the results of the British firms active in the armaments industry in this period.

John Brown and Cammell

John Brown and Cammell had monopolised armour plates production Britain since the 1860s. They supplied the Royal Navy and also exported part of their production, either by directly selling abroad armour plates or by supplying armour for foreign vessels ordered in Britain. The major issue they faced in the 1880s and 1890s was that of keeping pace with the evolving armour making technology.

Since the late 1870s, John Brown and Cammell had large operations geared towards producing compound armour, which they had introduced as a response to the first steel plates. Any improvements in steel armour production, however, would anticipate the demise of compound

technology and force them to undertake large investments to adapt their plants (for instance, when Cammell started producing steel plates, it purchased a new 5,000 tons hydraulic press for forging them). The superiority of steel plates was decisively confirmed by a trial in Annapolis in 1890. Two Schenider steel plates were tried side by side with a Cammell compound one, which was defined "incapable of standing the fire" and "very inferior".[52] Both John Brown and Cammell, however, experienced problems in manufacturing good steel plates. Only in 1888 did Cammell submit a steel plate for trial, twelve years after Schneider had first introduced them.[53]

From the late 1880s John Brown and Cammell lost the technological leadership they had enjoyed in the previous decades in favour of American and German firms. This was to a large extent a consequence of the British armour makers' early success. John Brown and Cammell's dominant position in compound armour making discouraged them from investing in alternative technologies that would have damaged their current business. Second, innovation in steel making was based on two factors: sophisticated chemical knowledge, and a long manufacturing experience necessary to learn how to apply theoretical insights. The increasing complexity of armour making magnified the relevance of these two elements. Simply speaking, John Brown and Cammell suffered from having a limited track record in armour steel making at a moment of rapid technical evolution. Their early start, and leadership in compound technology put them in a relative disadvantage in comparison with foreign competitors. It is important to highlight, however, that while John Brown and Cammell did not produce innovations comparable to the ones obtained, for instance, by Krupp, they were able to maintain their business success and thrive by rapidly acquiring access to major technical innovations. They were also favoured by their access to the single largest market for armour plates in the world – Great Britain. Finally, the fact that both ended up merging with naval shipbuilding firms, provided them with secure outlets for their production.

After successful trials in America, Harvey, who in 1891 took a British patent covering his invention,[54] tried to sell the rights of his invention in Europe which was the largest market for armour plates in the world. According to a family memoir, John Brown, Cammell and Vickers (which had recently entered armour production) initially showed no interest in Harvey's patent, something hardly surprising, considering that radical innovations could weaken their present position. When Harvey's agents threatened to create an independent armour making company, the three British firms accepted to arrived at a compromise.[55] It is important to analyse in some detail this agreement because it was the first of a series involving the exchange and circulation of patents

52 *Bulletin of the American Iron and Steel Association*, 24 September 1890.
53 Id., 21 May 1888, 10.
54 British Patent n. 16544, 'For the Carburising and Hardening of Armour'.
55 T. W. Harvey, *Memoir of Hayward Augustus Harvey by His Sons* (New York, 1900), 77-80.

between armaments companies.

Harvey's problem was that of maximising the return from his patent while, at the same time, reducing the incentive for the development of competing technologies. The solution was the creation of the Harvey Steel Company of Great Britain, with a capital of £ 180,000.[56] This company was an empty shell, whose only activity was to acquire the rights of the Harvey patent for Great Britain. Initially John Brown, Cammell and Vickers were its only three shareholders. At the same time two more companies were created: the Société de Precédés Harvey (capital of 3,000,000 francs) combined the major French armour making companies (St. Chamond, Chatillon and Marrel Frères, later joined by Schneider) and it owned the rights to use the Harvey patent in France, and the Harvey Continental Steel Company (capital of £120,000) which acquired the use of the Harvey patent in all other European countries. Krupp was its major shareholder.[57] These three Harvey companies operated in the same way: every shareholder who gained orders for Harvey armour plates paid a share of its profit to the Harvey firm it was associated with. These profits were distributed as dividends to compensate the shareholders who had gained fewer orders. The result was to stimulate each firms to acquire orders so as to increase their profits, while, at the same time, the arrangement compensated the firms doing less well, reducing the incentives for them to leave and try to develop different technologies.

These three firms, nominally independent, formed, together with the Harvey Steel Company of New Jersey, a syndicate for sharing armour technology. When Krupp came up with its own armour making system in mid-1890s, it did not exploit it independently, but, by contrast, it sold the right to use its patents to the various Harvey companies and consequently to French, British and American firms. At a first glance, this decision seems surprising. Two reasons, however, provide a rational justification. First, innovation in armour technology was very much a trial-and-error process. Krupp's patent could have been "rediscovered" by some other firm in a different country. In that case it would have problematic for Krupp to gain legal protection for its patents. It was more prudent to sell the rights for a lump sum and a share of dividends. Second, Krupp was certainly aware that even though foreign navies were keen to buy the most advanced plates, countries such as Britain or the France would not have bought any plate from it for both strategic and political reasons, but would have pushed national producers to come up with similar innovations.

In the course of the 1890s John Brown and Cammell enlarged their operations. Growing

56 No records of the various Harvey Steel Companies survive. Luckily, Vickers produced a document (VA, f. 58) which offers an overview of the various Harvey Steel Companies which it submitted to the Royal Commission on Private Manufacture of and Trading in Arms in 1934-35. This document, which until now went unnoticed, forms the basis of this paragraph.

57 Harvey, *Memoir*, 79.

demand and the high returns offered by armour making (in 1894 Harveyzed armour plates quoted between £75-65 a ton, steel plates for shipbuilding sold between £4 12s and £4 15s)[58] stimulated additional investments. In 1895, for example, John Brown purchased a 10,000 tons forging press, an 8,000 tons bending press and erected a new rolling mill.[59] The total cost of these investments ran into hundreds of thousands of pounds. The following year Cammell purchased a Whitworth press and its ancillary plant for £30,000.[60] However, judging from the minutes of Cammell's board, large capital investments represented just a share of the costs incurred by armour companies. A constant stream of small, but numerous, investments was required to enhance and adapt production.

Because of their growing armour production, by 1897 John Brown and Cammell faced a strategic problem. They had invested a lot to keep their armour production technologically up to date. At the same time, military technology had became so complex that it was impossible to rapidly adapt armour making plants to civilian business. Swings in the demand for amour plates could thus result in large losses. British naval spending was on the rise, but new firms were rumoured to be interested in entering the field. It was with the aim of reducing uncertainty and gain a secure outlet for their armour plates that John Brown and Cammell, as it will be covered in chapter VI, decided to vertically integrate, acquiring shipbuilding and, later, gun making capabilities.

Armstrong

In the years from 1882 to 1897, Armstrong experienced rapid growth. In 1882 Armstrong was already a large firm, employing around 4,000 workers and posting a net profit of £146,120. By 1897, however, it had become much bigger: it employed around 18,000 workers and its profits reached £442,868.[61] Armstrong's position was unique, because until the late 1880s it was the only private firm producing large naval guns and, until 1897, the only armaments company combining gun making with naval shipbuilding. Armstrong certainly benefited from Britain's increasing naval budgets but his success cannot simply be reduced to external circumstances: the firm displayed a remarkable capacity to develop new technologies, adapt to new trends, acquire new markets and enter into new productions.

In 1882 Armstrong merged with Mitchell to create the Sir William Armstrong and Mitchell

58 *Iron and Coal Trade Review*, 28 December 1894, 814.
59 A. D. Stacey, *A Historical Survey of the Manufacture of Naval Armour by Vickers Sons & Co., and their Successors 1888-1956*, 12, VA, f. 1153, 22.
60 WAS, Cammell, *Minutes*, 29 July 1896.
61 T&W, *Minutes of the Annual Shareholders' Meetings* 130/1329 and 1346.

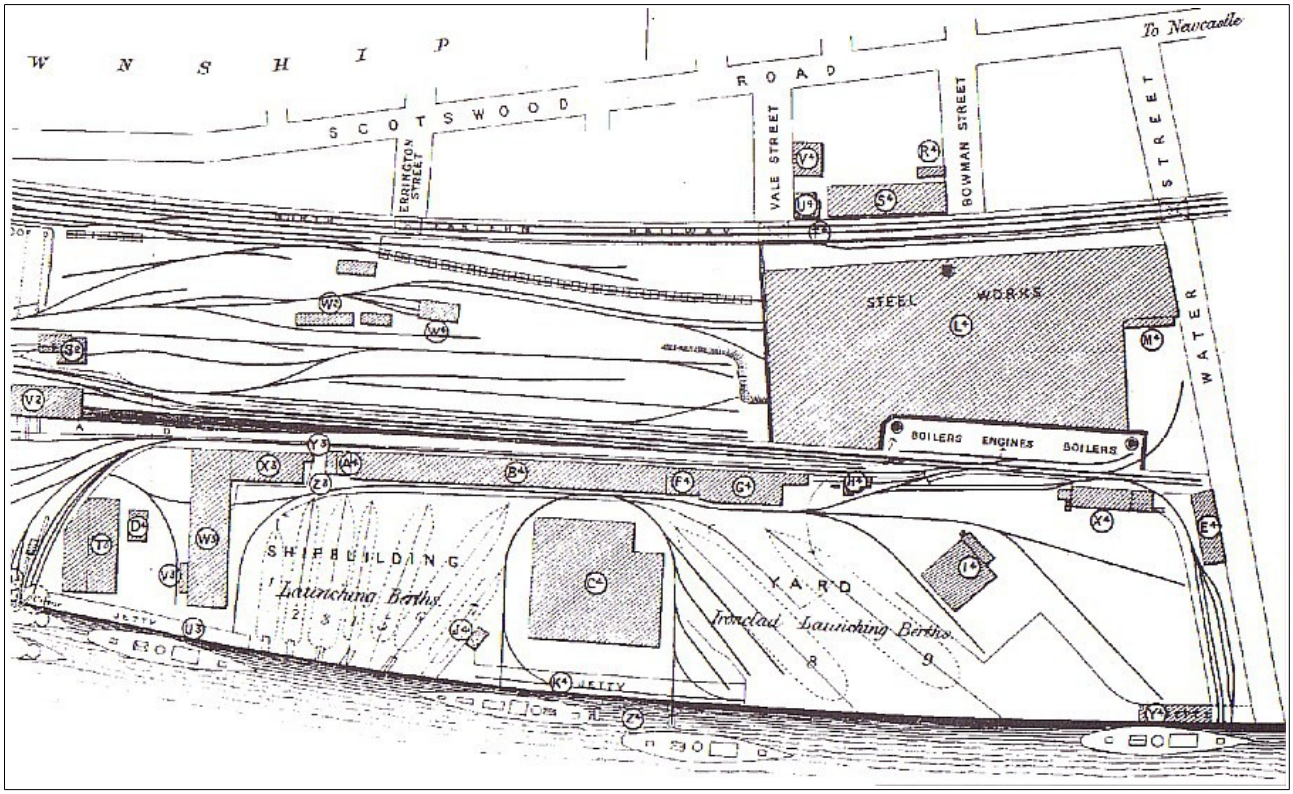
Company, with a capital of £2,000,000. 6,650 £100 shares were offered to for subscription, raising the capital needed to finance two major investments.[62] The first was the erection of a steel plant: until then Armstrong had purchased hoops and forgings from other firms, especially Cammell and John Brown. The introduction of steel guns, however, pushed Armstrong towards internalising production so to have full control over the quality and supply of the metal. To run the steel plant, Armstrong hired Colonel H. Dyer, who had worked for seven years with Whitworth and was an authority on the production of high-quality steel.[63] In addition, Armstrong also convinced William Siemens, another leading steel expert, to join the board, although he died only a few months after having taken up his post. The initial layout of the steel plant consisted of 3 rotary furnaces (later cancelled) and 2 12 ton open heart Siemens furnaces, plus gas producers and other ancillary components. The total estimated cost was initially put at £15,000.[64] Continuous investments were made to the steel plant and to the ordnance department. Already in 1883 a new boring machine (costing £1,560) and a travelling crane (£770) were purchased.[65] One year later, £6,800 were spent for several new machines.[66] By 1885, steel output ran at 120 tons a week. The executive committee soon decided to invest £31,000 to quadruple the output. A 30 ton melting furnace and a forging press (costing alone £10,000) were purchased.[67] The firm could now count on a reliable and high-quality supply of forgings and other steel pieces, and the share of the output not consumed internally was sold on the open market. Armour plates, however, were not manufactured at Elswick, but the firm kept buying them.

The second investment was the creation of the Elswick yard exclusively devoted to naval shipbuilding (before 1914 just 7 merchant vessels were built there versus nearly 100 warships). In 1885 the *Panther*, an Austro-Hungarian cruiser, was the first vessel to be completed there. At first glance, building a new yard seems an odd choice for a company which had just merged with a shipbuilding firm. Actually, the construction of Elswick yard was the key step which allowed Armstrong to rapidly secure a leading position in the world armaments trade.[68]

The yard, designed by Mitchell, simplified the firm's logistics: it was located on the riverside in front of the artillery plant, whereas Low Walker was several miles downstream. At the beginning of the 1880s a positive trend in merchant shipbuilding was keeping Low Walker busy. To divert its activities to naval shipbuilding would have meant losing business opportunities.

62 *The Times* 18 November 1882, 11.
63 T&W *Rendel Papers*, 31/6538, 10 October 1882.
64 T&W, 130/1264, *Minutes of Meeting of the Board*, 9 March 1883 and 26 March 1884.
65 Id., 25 October 1885.
66 Id., 30 January 1884.
67 Id., 29 July 1885.
68 VA 1157 contains documents on the construction of the new yard.

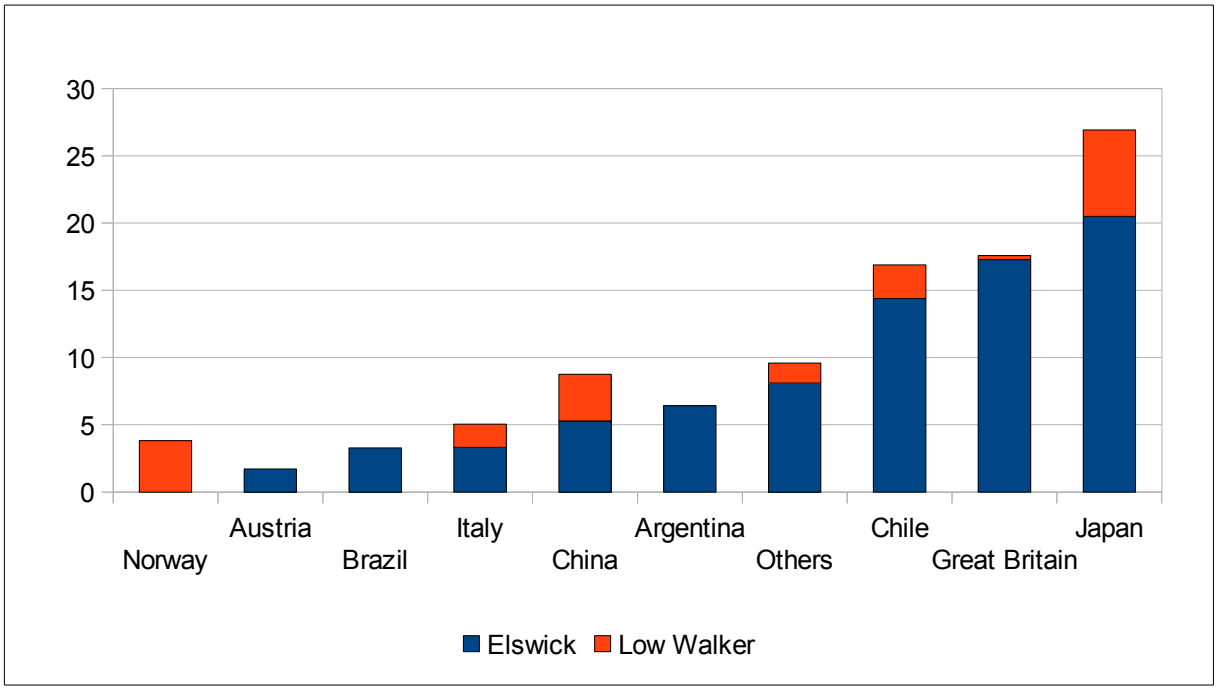
Figure 3.9: Plan of the Elswick yard, circa mid-1880s. The Steel works are immediately north of the yard.



Source: http://www.tynebuiltships.co.uk/Armstrong-Mitch-Elswick.html

In addition, commercial reasons justify this investment: as pointed above, in the early 1880s artillery was rapidly evolving and Armstrong enjoyed an outstanding reputation as maker of naval ordnance. Some foreign customers, such as Italy, for example, purchased from Armstrong ordnance and mountings but undertook naval shipbuilding at home; other countries, however, such as Argentina or China, had to buy abroad both vessels and their artillery because they lacked a modern domestic shipbuilding industry. By acquiring the capacity to built warships, Armstrong became able to complete warships: a foreign government could, then, with a single contract, purchase a fully armed naval vessel, simplifying and speeding up its procurement. Until the 1890s only Armstrong was able to offer such a "ship plus guns" package. This explain why of the 179,685 tons of warships made by Armstrong in the period 1882-1897 more than 80% was purchased by foreign customers.

Figure 3.10: major purchasers of warships laid down in Elswick and Low Walker in percentage of the total tons of warships produced, years 1882-1897.



Source: VA 818, *List of ships built at Elswick and Walker yard*.

The bulk of Armstrong's production was made up of medium size vessels such as cruisers, rather than large capital ships. The average displacement of the vessels built in the period 1882-1897 was 2,787.6 tons, and only 5 out of 62 displaced more than 5,000 tons (four of which were made after 1893). A tendency towards larger vessels was evident, though. The average displacement increased from 1,825 tons in the years 1882-1889 to 3,982.6 in the period 1890-1897. Armstrong's focus on these kinds of vessels was a direct consequence of the fact that the firm sold them mainly abroad. Foreign navies usually had modest budgets. Battleships were too expensive for them, while cruisers were a more affordable investment. This suited Armstrong perfectly: cruisers had none or limited protection (the company had no armour making capacity) while guns represented a larger share of their final cost (usually a third of the total).

Armstrong's ordnance production was more balanced between domestic and foreign sales. The company's records preserve data on payments for works in progress in the period 1884-1895. In the absence of better data, they help to assess the relevance that various customers had for Armstrong. In those years, the British Admiralty and War Office accounted for a total of £3,993,030, that is 36.23% of the total payments received by the firm.[69] Given that the payments

69 For a full breakdown of payments, see Figure 5.2 in chapter V.

referred also to shipbuilding activities, and the Admiralty ordered only a few vessels to Armstrong, this demonstrates how important the British demand for gun and mountings became for Armstrong in the 1880s and 1890s.[70] Foreign governments provided Elswick with large orders, but there was no guarantee that they would keep buying in the future. They could face financial difficulties, as, for example happened to Turkey, or switch, for political or commercial reasons, to a different supplier, as China did when it started to buy from Germany. At the opposite, to become a regular supplier to the largest navy in the world meant gaining a substantial and regular stream of orders.

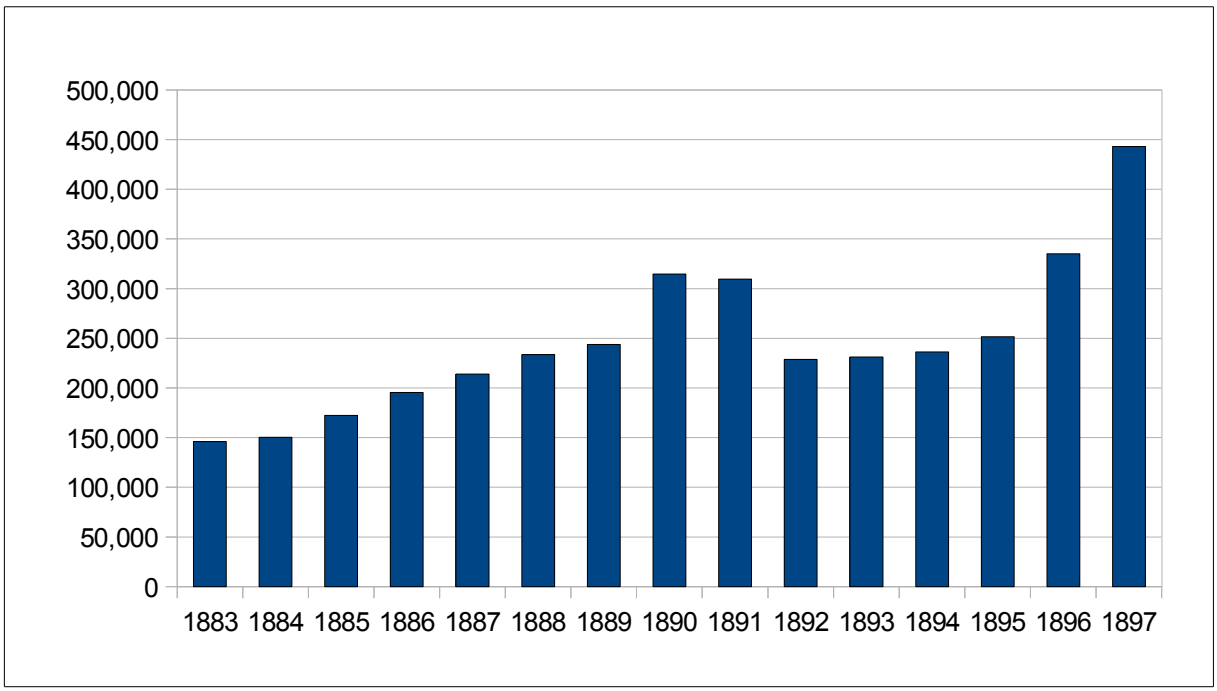
It took years, however, for Armstrong to secure a position as an important supplier for the Royal Navy. In 1877, for instance, an internal report by the Navy concluded that the new German medium artillery was performing better than the comparable British one.[71] Equally, French vessels, despite being of inferior quality, carried more powerful guns.[72] Inside the Admiralty some officers accused Woolwich of being too slow in adopting new innovations such as breech loading. Others, however, displayed a more conservative attitude and helped delay the transition to breech-loading artillery.[73] In 1878 Armstrong directly approached the Admiralty: he submitted the designs of new breech loading guns, and "offered any assistance in the investigation which may take place."[74] Armstrong's proposal was opposed by the War Office, at that time still responsible for the supply of artillery to the Navy, which favoured Woolwich. In 1879, after the incident on board of HMS *Thunderer* proved the superiority of breech-loading guns, the Admiralty wrote to the War Office that it "inclined towards Armstrong-design breech-loading guns for *Colossus*, *Majestic*, and *Conqueror*."[75] The War Office replied recommending, on the contrary, to equip the new battleships with the 43 ton breech-loading gun designed by the Royal Gun Factory.

Woolwich, however, was not able to provide a final design for the new 12 in. guns breech-loading guns until February 1882. This resulted in long delays: several ironclads entered service without all their major guns fitted on board. While Woolwich was still designing the new breech-loading loading gun, Armstrong started manufacturing 13.5 in. and, a little later, the larger, but less successful 16.25 in. breech-loading guns. It was during the transition to breech-loading artillery, which was much more complex and difficult to produce, that Armstrong started to enjoyed a clear technical edge over Woolwich. From mid-1880s, therefore, Armstrong received a steady stream of orders from the Navy, a trend reinforced after 1888, when the Admiralty finally gained control of

70 M. J. Bastable, *Arms and the State. Sir William Armstrong and the Remaking of British Naval Power, 1854-1914* (Aldershot, 2004), 188-189.
71 NA, ADM 1/6422, 26 June 1877.
72 NA, ADM 1/6424, 15 November 1877, report of Captain Nicholson, naval attaché in France,.
73 Beeler, *Birth*, 83-84.
74 NA, ADM 138/60.
75 Id., 28 August 1879.

the procurement of artillery for the Navy. For instance, of the 22 large calibre guns which arming the six vessels of the *Admiral* class, 18 were ordered from Elswick, and just 4 were supplied from Woolwich. Elswick's success in this period can be gauged by the continuous rise of its profits, as shown in figure 3.11. The decline in profitability in the early 1890s was the result of a protracted series of strikes, rather than of a decline of sales.

Figure 3.11: Armstrong's final year profits, 1883-1897 (in current pounds).



Source: T&W, *Printed annual reports*, 130/1329-1344.

While external circumstances greatly helped the growth of Armstrong, the core of the firm's success rested on its continuous attention to innovation and its ability to acquire the technical capabilities it required from outside the firm. For instance, it was Andrew Noble who, together with Frederick Abel, started to experiment with slow burning explosives in the late 1870s, and they developed one of the various brown powders whose patent the firm retained.[76] Slow burning explosives were, as it has been said above, crucial to accelerate the transition to breech-loading artillery. Before that, Armstrong had demonstrated its technical capacity producing massive breech-loading 100 ton guns, a feat which the Royal Gun Factory could not replicate.

The firm also played a key role in the development of quick-firing guns. Small artillery with

76 HCPP, *Report of the Royal Commission Appointed to Inquire into the System Under Which Patterns of Warlike Stores are Adopted and the Store Obtained and Passed to Her Majesty's Service* (1887), qs. 8169-8172.

high rates of fire had already been devised by the French firm Hotchkiss.[77] Armstrong's management was aware that the absence of effective anti-torpedo boat countermeasures reduced the effectiveness of warships to the point that the idea of keeping to build them was questioned, something which could seriously damage its large ordnance business. In order to gain the technical know-how it required, and to dispose of a potential rival, Armstrong purchased in 1883 the small London gun making firm of Josiah Vavasseur, an engineer who in 1877 had patented a new design for hydraulic mountings but who lacked the resources to organise large-scale production and the contacts needed to market his wares.[78] Vavasseur became a director of Armstrong and replaced Stuart Rendel as the firm's representative in London.[79] Vavassuer's patents were used by Armstrong to design the first quick-firing naval gun (with a calibre of 4.7 in.) which proved an immediate success and was widely adopted by many navies.[80]

Vickers

Vickers was founded in Sheffield in 1829 as Naylor, Hutchinson, Vickers & Company, a family firm operating in the steel business. The steel trade was a fast growing sector and the firm's operations expanded greatly in the 1840s, when it started to supply the American market. By the end of the decade, Vickers ranked among the largest firms in Sheffield.[81] Thomas and Albert, the son of Edward Vickers, the founder of the company, were sent to Germany to study chemistry and gain a first-hand knowledge of new production processes.[82] Such a decision indicates how Edward was well aware of the need to position Vickers in the high-quality end of the market, differentiating it from the many other steel firms in Sheffield: technology was the key to gain, and retain, such a position.

Thomas Vickers was a talented metallurgical engineer who personally held several patents relevant for the company's business. When he took control of the firm he decided to develop the engineering side of the business. Until then, Vickers had mainly produced steel by crucible technology; now, the firms moved into the production of semi-finished and finished goods such as propellers, steel tyres, shafts and heavy forgings, which rapidly became the core activity of Vickers.

77 See P. Smithurst, 'Hotchkiss 37mm revolving cannon', in *Royal Armouries Yearbook*, vol. 2 (Leeds, 1997), 90-106.
78 See Vavasseur's obituary, *The Times* 25 November 1908, 20.
79 T&W, 130/1264, *Minutes*, 25 January and 22 February 1883.
80 Brook, *Warships*, 11; Campbell, 'Naval armaments', 163.
81 G. Tweedale, *Steel City. Entrepreneurship, Strategy, and Technology in Sheffield, 1743-1993* (Oxford, 1995), 51.
82 Id. 'Vickers, Thomas Edward and Albert', *ODNB*.

In the 1860s Vickers was regarded as "the best specimen of mechanical engineering at present in existence [in Britain]" by the American industrialist Abram Hewitt.[83]

In 1867 Vickers went public as Vickers, Sons & Co. with a capital of £155,000. Already in 1871 the authorised capital was raised to £360,000; in 1878 to £500,000.[84] Judging from this yardstick, Vickers was a fast growing firm, though still smaller than Cammell and John Brown because their involvement in the capital-intensive armour making required a higher level of capitalisation. In the 1870s, high tariffs reduced access to the American market, but the firm was able to find new markets and develop new line of products. For instance, Vickers started to manufacture naval hardware such as screw propellers, marine shafting, etc. to take advantage of booming merchant constructions. In 1881 Vickers raised its capital to £750,000. Through constant investments and a focus on quality, the firm had gained a leading position in the British steel industry. As Clive Trebilcock underlines: "well before the transition to the armaments specialism was commenced, the Vickers concern was operating at the peak of contemporary technical practice within its sector: its qualification for refined industrial work were already well attested."[85]

Until the 1880s, Vickers's involvement in military production was limited: it supplied Woolwich and Armstrong with steel hoops, tubes and forgings for guns, but did not carry out any specifically military production. Vickers decided to enter into the armaments sector as a response to the changing circumstances in the steel industry. In the 1870s, Vickers distributed dividends of more than 10% on average.[86] The firm's position at the top end of the steel market helped it to thrive in a period during which Sheffield's steel industry was suffering from both internal competition from other British regions (Middlesbrough and South Wales, especially) which had access to cheaper coal and better connections, and from foreign producers in Belgium, Germany and France. From 1884 onwards competition intensified and Vickers's profitability plummeted (dividends fell to 4%).[87] Even though the minutes of the board are often just a few sentences – Thomas and Albert Vickers had a very autocratic management style – they made clear that the company was looking for new businesses to enter. Under these circumstances the expanding demand for armaments represented a large source of potential demand. Vickers was in a very good position to successfully expand into this new field: it was a well known firm which enjoyed a good reputation for high-quality products. It could then easily raise capital and use its name as a guarantee of excellent products. Having supplied Woolwich and Armstrong for years it was familiar with government's

83 J. C. Carr and W. Taplin, *A History of the British Steel Industry* (Oxford, 1962), 47.
84 J. D. Scott, *Vickers. A History*, 17.
85 C. Trebilcock, *The Vickers Brothers. Armaments and Enterprise, 1854-1914* (London, 1977), 29.
86 VA 768, *Annual Reports and Accounts*, various years.
87 VA 1470, *Minutes of the General Meeting with Shareholders*, 1884.

technical requirements. It is likely that Vickers informally approached the government to assess if there was room for an additional private supplier of guns and armours. The answer was certainly positive: Armstrong was struggling to keep up with the rapidly expanding demand for guns and, at the same time, Woolwich was judged by the same War Office as poorly equipped.[88] In 1887 the firm doubled its capital, issuing an additional £750,000 of shares to finance the investments needed to enter into armaments production. The reasons behind such a decision were neatly explained in the firm's report to the shareholders the following year:

> The Directors have to report that during the first six months of the present year the works have been fairly employed, although, owing to the severity of the competitors, the prices obtainable for works have not been as satisfactory as they should have been. On the other hand, the Directors are glad to report that they are on the point of concluding an important contract for a number of finished heavy guns, and though the execution of this contract will involve a considerable outlay in special machinery, yet when the plant is once established, this branch of the business should continue to be a permanent and profitable one.[89]

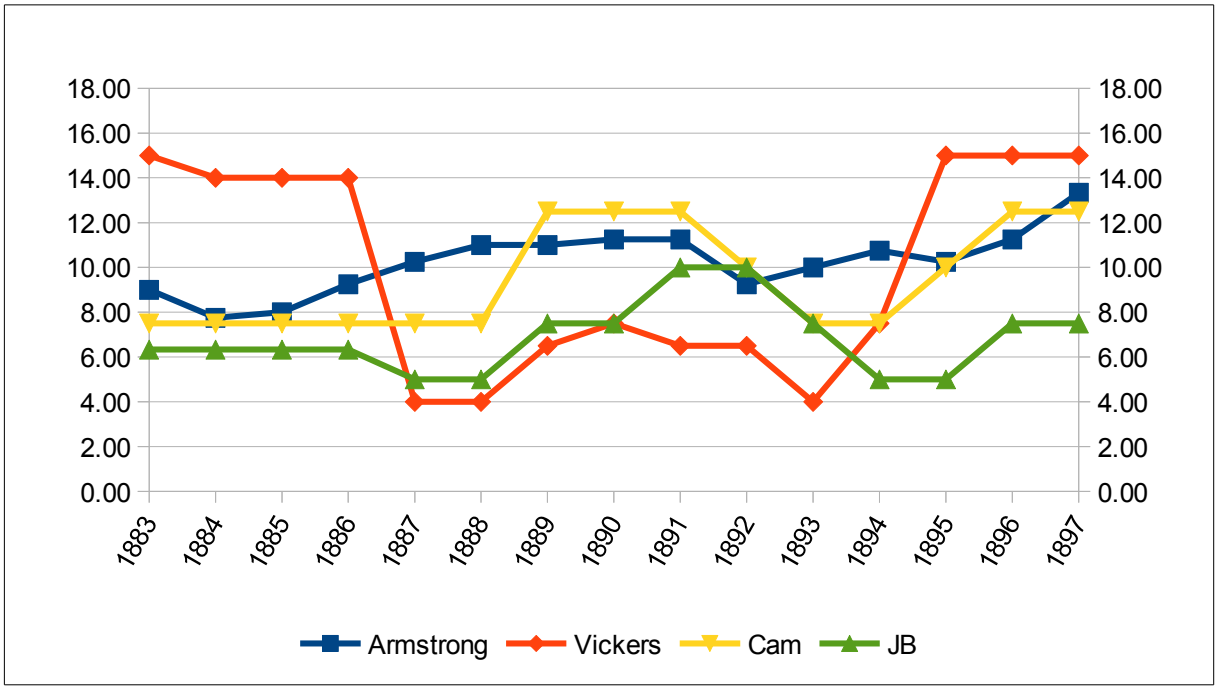
The following year the company's first armour plates was successfully put on trial. As a result, "[Vickers's] name has been put upon the Admiralty list of armour plate makers, and we have in consequence secured contracts."[90] In 1890 the firm produced its first naval heavy gun. Favourable market conditions and the firm's technical capabilities resulted in Vickers's rapid success in the armaments trade. For example, Vickers, which was not bound to an old technology, was the first company to show interest for the Harvey patent in Britain. Until 1897, however, Vickers was, in the definition of Scott, a "half-way house".[91] It was a steel firm with a foot in armaments manufacturing, and, in comparison with Armstrong, it lacked both the capacity to build small, quick-firing, armaments, and warships.

Figure 3.12 compares the dividends paid by Armstrong, Vickers, John Brown and Cammell in the period 1883-1897 while Figure 3.13 shows the average and the standard deviation σ^2 (a measure of dispersion of the values from the average) of the dividends paid by the major four

88 *Directory of Army Contracts,* 'Report, 1888-89', *passim*.
89 Id., 17 August 1888.
90 Id., 16 August 1889.
91 Scott, *Vickers*, 43.

armaments companies.

Figure 3.12: Dividends, as percentage of issued capital, paid by Armstrong, Vickers, Cammell and John Brown, 1883-1897.



Source: Armstrong: *Financial Times* 28 January 1898, 3; Vickers: Scott, *Vickers*, 389-90; John Brown and Cammell: Tweedale, *City*, 124-125; data from *Stock Exchange Year Book* have been used for missing years.

Figure 3.13 Average and standard deviation of dividends paid by Armstrong, Vickers, Cammell and John Brown in the years 1883-1897.

	Armstrong	**Vickers**	**Cammell**	**John Brown**
Average	10.24	9.9	9.5	6.85
σ^2	1.38	4.5	2.27	1.56

Source: see figure 3.12.

Figures 3.12 and 3.13 highlight how Armstrong paid on average the highest dividends, and also how stable was their level (Armstrong's σ^2 was the lowest). The fact that Armstrong was active in various military productions (large ordnance, shipbuilding, quick-firings) favoured the firm

which could count on a large market and on limited competition. The three Sheffield companies, at the opposite, were on average less profitable and their dividends more irregular. All these firms still retained large civil businesses which were subject to stronger competition. Vickers paid high dividends in the early 1880, but then its profitability plummeted. The need to finance large investments to enter the armaments trade partially explain the low level of dividends in the late 1880s and early 1890s. Vickers returned to pay large dividends, higher than Armstrong's, in the second half of the 1890s. John Brown and Cammell's involvement in military production was in these years limited to armour plates, whose demand had a significant impact (the peak in the late 1880s was caused by the additional demand for armour generated by the Naval Defence Act) and they too had to spend large amount of resources to modernise their plants. In general, Cammell paid higher dividends than John Brown.

Clyde naval shipbuilding firms

The Clyde shipbuilding cluster is the last case analysed. Between 1889 and 1914 shipbuilding firms based on the Clyde built 793,481 tons of warships for the Royal Navy, that is the 44,56% of the total tonnage contracted by the Admiralty.[92] The Clyde represented, then, the single largest private supplier of warships for the Royal Navy in the twenty-five years before 1914. This part covers the early development of the Clyde shipbuilding industry, that is before the integration of various shipbuilding and armaments companies in late 1890s. Until that moment, Clyde-based firms were exclusively active in the production of hulls and engines for warships. These two productions were less "military" in nature than armour or gun making: building the hull of a warship was more difficult and complex than that of a merchant ship, but with little problem and limited investments the same yard could undertake, technically, if not economically, both civilian and military works.

The first yard to carry out naval shipbuilding on the Clyde was that of Robert Napier.[93] Napier won the tender for the construction of HMS *Black Prince*, the second sea-going British ironclad, which was laid down in 1859 and launched in 1861. The contract was part of the Admiralty's strategy of enlisting private yards to rapidly built ironclads. Napier did not make a profit out of this contract: ironclads were a new kind of vessels and it was difficult to forecast the final cost; moreover, he incurred additional expenditures to produce iron plates according to the

92 Calculations based on Parkes, *British Battleship*.
93 M. S. Moss, 'Napier, Robert', in *ODNB*.

Admiralty's specification. At the end, the government compensated him with £35,000.[94] Notwithstanding the poor financial returns, this first contract provided Napier with good publicity and he secured additional orders from the Admiralty and from foreign governments. The largest contract was for three frigates for Turkey. The Royal Navy awarded contracts also to a few other Clyde firms, among which John Elder & Co. (later Fairfield Company) and J. G. Thompson (later, Clydebank Engineering Company) were the most important.[95]

The relationship between the Admiralty and the private shipbuilding industry followed the same pattern which had shaped the one between the War Office and Armstrong in the late 1850s and early 1860s. Technical evolution caused a period of crisis for the traditional procurement structures – the Royal Dockyards or the Royal Gun Factory. This forced military bureaucracies to rely on private suppliers. As soon as the public structures adapted themselves, however, they were again favoured, limiting the contracts with private firms. The Clyde did not escape the general reduction in orders (figure 3.14). The Admiralty kept buying a few vessels (and a larger number of engines), but the general trend was downward. At the same time, private yards themselves tended to shun military orders: during the 1870s commercial shipbuilding was booming, offering plenty of opportunities, while production for the Admiralty, because of the absence of standard designs and the continuous request for changes and ameliorations, was longer and more costly.[96] The overall effect was that works for the Admiralty lost relevance for the Clyde firms.

Figure 3.14: Iron tonnage produced for the Royal Navy, 1859-1884.

Years	Royal Dockyards (tons)	Private yards (tons)	% of private orders over dockyard's	Clyde-based firms (tons)	% of Clyde over private orders
1859-69	64,841	142,905	220.4	34,723	24.3
1869-79	151,268	59,383	39.3	38,691	65.2
1879-84	123,830	29,670	24.0	14,480	48.8

Source: Conway's, *All the World Fighting Ships*, passim.

94 H. B Peebles, *Warshipbuilding on the Clyde* (Edinburgh, 1987), 12-13.
95 Id., 18.
96 *Report of the Committee Appointed to Inquire into the Condition Under Which Contracts are Invited for the Building or Repairing of Ships, including their Engines, For Her Majesty's Navy, and into the Mode in Which Repairs and Refits of Ships are Effected in Her Majesty's Dockyards* (1884-85) (Ravensworth Committee), HCPP, qs. 262-264, 1535, 1758-1759.

The relationship between Clyde firms and the Admiralty changed as a consequence of the naval programmes of the 1880s. More vessels were required, but there was a limit on the number of warships the Royal Dockyard could build. Therefore orders to private firms escalated. For instance, in the years 1884-1889, the Royal Dockyard built a total of 103,403 tons, and private yards 95,965 (60,560 as direct consequence of the Northbrook programme), of which 32,870 tons were built on the Clyde. This trend was greatly reinforced by the Spencer naval programme, the subsequent budget increases needed to preserve the "two power standard" and the contemporary introduction of torpedo destroyers whose design and construction the Admiralty decided to leave to private firms.[97]

The relationship between Clyde-based firms and the Admiralty from the 1880s onwards, however, was very different from that of the 1860s. Then Clyde firms had received orders because they enjoyed a technological advantage: they could produce iron vessels, while the Royal Dockyard could not. The advantage was short-lived, though: iron construction was relatively easy to master, and the Royal Dockyards rapidly acquired the know-how. Twenty years later the Clyde returned to be an important centre of naval shipbuilding, but this time the reasons favouring it were not technological, but organisational. The Admiralty did not order vessels because it could not make them (with the exception of destroyers). It ordered them because its yards were too busy to undertake additional constructions. The higher level of naval design standardisation led to a reduction of uncertainty. This allowed the Clyde to exploit the organisational capabilities (flexibility, high productivity, diffused technical know-how, etc.) which the district had developed in merchant shipbuilding, and which allowed it to build rapidly and efficiently.[98] The Admiralty sent the designs which Clyde firms followed, introducing virtually no improvements or innovations. As the First Lord of the Admiralty George Hamilton said in 1890, "Dockyard-built ships of each type [were given] a sensible start upon contract-build ships of similar type in order that all details might be thoroughly worked out in Dockyards by naval and professional officers and thus be available for guidance in the construction of contract ships".[99]

Despite the opportunities offered by the growing naval budget, the ability to acquire orders was linked to each single firm's capacity. Thus a small group made up of the largest firms – Clydebank, Fairfield and Scott's – received all the orders for battleships and first and second class cruisers, precisely because they were the firms equipped to lay down large hulls. At the same time, government contracts usually offered positive returns despite the level of profitability was not uniform among companies.[100] Orders from the Admiralty were especially sought after in periods of

97 E. J. March, *British Destroyers: a History of Development, 1892-1953* (London, 1967), 21-26.
98 Peeble, *Warshipbuilding*, 137.
99 *Statement of the First Lord of the Admiralty Explanatory of the Navy Estimates*, HCPP (1890).
100Peeble, *Warshipbuilding*, 34-39.

merchant shipbuilding slowdown, as in 1895.

Two additional features of Clyde's naval shipbuilding activities between 1889 and 1897 must be stressed. The first is that Clyde firms exported very little of their warship production. In these years they built just 6,437 tons for foreign governments, a fraction of what Elswick sold abroad. This was because foreign customers came to Britain either to acquire the most sophisticated components (guns, mountings, etc.) or complete warships. Therefore it was the more integrated armaments companies which gained foreign orders, rather than simple naval shipbuilding firms. The second is that naval construction represented an additional, usually profitable, side activity for the largest firms, but warships represented only a small fraction of the total Clyde output (although it certainly represented a higher percentage in terms of value), as data showed in figure 3.15 make clear.

Figure 3.15: warship and merchant tonnage as a percentage of Clyde's total output, 1889-1897.

	Warship construction (in tons)	% of warship construction over total construction	Merchant construction (in tons)	% or merchant construction over total construction	Total output
1889	6,810	2.03	328,391	97.97	335,201
1890	9,690	2.68	352,488	97.32	362,178
1891	14,300	4.4	311,177	95.6	325,477
1892	22,817	6.78	313,597	93.22	336,414
1893	0	0	280,160	100	280,160
1894	840	0.25	340,045	99.75	340,885
1895	42,112	11.7	318,040	88.3	360,152
1896	24,425	5.8	396,416	94.2	420,841
1897	13,665	4.01	326,372	95.99	340,037
	134,659		**2,966,686**		**3,101,345**

Source: Calculations based on data in Peebles, *Warshipbuilding*, appendix A.

3.4 *Conclusions.*

The British armaments industry grew substantially in the last two decades of the 19th

century. Two major trends explain this. The first was the extensive application to naval armaments of the technologies which characterised the second industrial revolution (especially steel and chemicals). This resulted in more complex and expensive hardware whose production requires large, continuous investments which only heavily capitalised firms could undertake. The second was the substantial expansion of the British naval budget which generated plenty of new opportunities for firms manufacturing military goods. For example, both Vickers and the Clyde shipbuilding firms took advantages of the ballooning military spending.

At the end of the century, however, the British armaments industry was still fragmented. Only Armstrong had already integrated military shipbuilding and gun making into one company. This fact explains why the Newcastle-based company enjoyed such a long-standing success in the export markets. At the same time, Vickers, John Brown and Cammell had invested large amount of money to modernise and enlarge their plants, but they still lacked secure outlets for their productions, because they did not control yards which could absorb their output. In a still different position were the Clyde shipbuilders, which were active in the less technologically complex phases of military production – the making of hulls and engines – and lacked any integration with other military productions.

Chapter IV

The Development of the Armaments Industry in Italy, 1880-1900

This chapter focuses on the development of the private armaments industry in Italy in the last two decades of the 19th century. In this period, the Italian armaments industry developed considerably: in 1884 Terni, the first modern Italian steel company, was created specifically with the aim to make armour plates for the Navy. A year later, Armstrong established a plant for the manufacture of guns at Pozzuoli, near Naples, the first private gun making firm in Italy. This was the largest foreign direct investment ever made by Armstrong in its history, and probably the single largest ever made by any armaments company before 1914. The creation of Pozzuoli, because of its relevance for both the history of the armaments industry in Italy and for the impact it had on Armstrong, is the subject of a more in-depth analysis in the next chapter. Taking advantage of the fact that the Italian naval budget rapidly expanded in the 1880s, also Ansaldo and Orlando increased their activities in military shipbuilding. In the 1890s naval expenditures fell, even though remained at a level higher than that of the 1870s.

Support private firms to allow them to expand their operations and free Italy from the need to import military hardware was the linchpin of the strategy of Benedetto Brin, Italian Ministry for the Navy for the majority of the 1880s. The Navy backed private investments by using various means: financial advances, long-term contracts etc. As it will be shown, such a policy was not unanimously popular among military officers but, at the end, Brin's opinion prevailed. The result was that, while until the late 1870s a proper Italian armaments industry did not exist, at the end of the 19th century several firms were active in military production. The orders for warships which Ansaldo and Orlando received from various foreign governments at the end of the century were a signal of the Italian armaments firms' growing capacity to compete in the international markets.

The chapter is structured as follow: the first part considers the Italian naval budget and naval policy. The second deals with the creation of Terni and explains why the Italian Navy kept supporting it, despite financial and technical difficulties experienced by the firm. The third analyses the growing activities of Ansaldo and Orlando. The fourth part addresses the impact that Italian protectionist policies had on the armaments sector.

4.1 *Naval budgets and naval policy, 1880-1900.*

During the 1880s, the Italian naval budget increased significantly. In this decade the balance of power in the Mediterranean represented the central foreign policy preoccupation of the Italian governments.[1] The relationship between Italy and France had grown increasingly confrontational in the course of the 1870s. Worryingly for Italy, French naval construction's budget tripled during the second half of the 1870s though, admittedly, from a low starting level.[2] The French seizure of Tunisia in 1881 caused a new peak of tension.[3] Italy had harboured the idea of transforming Tunisia into a colony: Tunisia lies only 90 miles away from Sicily and there were around 20,000 Italians, who had been able to integrate in the local urban economy without generating much antagonism among the local population,[4] versus only around 200 Frenchmen.[5] In addition, the Bey of Tunis had granted railway concessions – an instrument of commercial penetration routinely used by the would-be colonial powers to assert their interests – to a consortium in which Italian interests were a majority.[6] France, however, could not accept that another country would be in the position to menace Algeria; thus in 1881, it invaded Tunisia and forced the Bey Muhammad III as-Sadiq to grant France a protectorate over the country.

The French *coup de main* generated loud cries of protest in Italy, but in vain. Britain wanted two different, and competing, powers to hold the opposite coasts of the Sicilian Channel, which divided West and East Mediterranean. If Italy had controlled both Tunisia and Sicily, she could have been able to cut the Gibraltar-Malta-Alexandria route.[7] Bismark saw Italian anti-French feelings as a useful way to lure Italy towards a central European alliance. African expansion, moreover, could

1 B. Sullivan, 'The Strategy of the Decisive Weight: Italy, 1882-1922', W. Murray, M. Knox and A. Bernstein (eds.), *The Making of Strategy: Rulers, States and War* (Cambridge, 1994), 316-317; D. Grange, 'La Méditerrenée dans les Rapports Franco-Italiens au Début du 20th Siècle', M. Perticcioli (ed.), *Verso la Svolta delle Alleanze. La Politica Estera dell'Italia ai Primi del Novecento* (Venezia, 2004), 13-15.

2 T. Ropp, *The Development of a Modern Navy: French Naval Policy 1871-1904* (Annapolis, 1987), 75.

3 W. L. Langer, *European Alliances and Alignments 1871-1890* (Cambridge, 1939), 217-250; A. J. P. Taylor, *The Struggle for Mastery in Europe* (London, 1954), 272-275.

4 J. Clancy-Smith,'Marginality and Migration: Europe's Social Outcasts in Pre-Colonial Tunisia, 1830-81', E. Rogan (ed.), *Outside In: On the Margins of the Modern Middle East* (London, 2002), 149-182.

5 On the relationship between Italy and Tunisia before and after the French annexation M. Choate, 'Tunisia Contested: Italian Nationalism, French Imperial Rule, and Migration in the Mediterranean Basin', *California Italian Studies* 1 (2010), 1-20.

6 L. Del Piano, *La Penetrazione Italiana in Tunisia (1861-1881)*, (Padova, 1964), 25.

7 This was exactly what happened during the Second War World, G. Giorgerini, *La Guerra Italiana sul Mare. La Marina tra Vittoria e Sconfitta 1940-43* (Milano, 2001), *passim*.

divert France from the idea of regaining Alsace and Lorraine.[8] It is hardly surprising, therefore, that in 1882 Italy secretly joined Germany and Austria to form the Triple Alliance. This was a nominally defensive military agreement which for Italy had the virtue of securing the country powerful allies in case of new disagreements with France.[9]

The conflict with France led Italy to expand its military budget. Military expenditure had been on the rise since the early 1870s. In 1871 the total military budget (that is the sum appropriated for both the Navy and the Army) was 190 million Lire. In 1877 it arrived at 250 million Lire and it stayed at this level until 1880. Such a rise had been to a significant degree unavoidable: in the second half of the 1860s total military expenditure had been cut, for the sake of balancing the budget, well below 200 million Lire a year. Such a low level of expenditure led to questions about the real capability of the armed forces to defend the country. The French-German War of 1870-71 stimulated a first wave of reforms: under the plan drawn by General Ricotti Magnani, the Italian army adopted a new organisation structure based on the German model of universal conscription.[10]

The rise in military expenditure, however, became more pronounced in the 1880s. By the end of the decade, total military expenditure was around 420 million Lire (although expenditure did not stay at such a level for long). New fortifications were erected on the North-West frontier and around Rome, to protect the capital from a French landing.[11] At the same time the total number of military personnel increased by 35%, from around 165,000 to more than 230,000. The majority of this increase was the result of the enlargement of the Army from ten to twelve corps, but the number of seamen increased proportionally more.[12] Figure 4.1 shows naval expenditure in Italy from 1880 to 1900.

In 1880 the government's spending for the Navy totalled around 45 million lire. By the mid 1880s the budget had doubled. As Prime Minister Francesco Crispi said in October 1887, “We need a stronger Navy, to make our influence in the Mediterranean more evident and appreciated.”[13] In 1889 the budged touched the sum of 160 million lire, an increase of more than 300% in just a decade. The 1889 balance was characterised by very large extraordinary expenditures, but ordinary

8 W. L. Langer, W. L., ‘The European Powers and the French Occupation of Tunis, 1878-1881’, *The American Historical Review* 31 (1925), 55-78, and id. 31 (1926), 251-265.

9 The standard history of the Triple Alliance is L. Salvatorelli, *La Triplice Alleanza, Storia Diplomatica 1877-1912* (Varese, 1939); see also G. Candeloro, *Storia dell'Italia Moderna*, vol. 6, *Lo Sviluppo del Capitalismo e del Movimento Operaio 1871-1896* (Milano, 1978), 156-164.

10 J. Whitman, *Storia dell'Esercito Italiano* (Milano, 1979), 160-164.

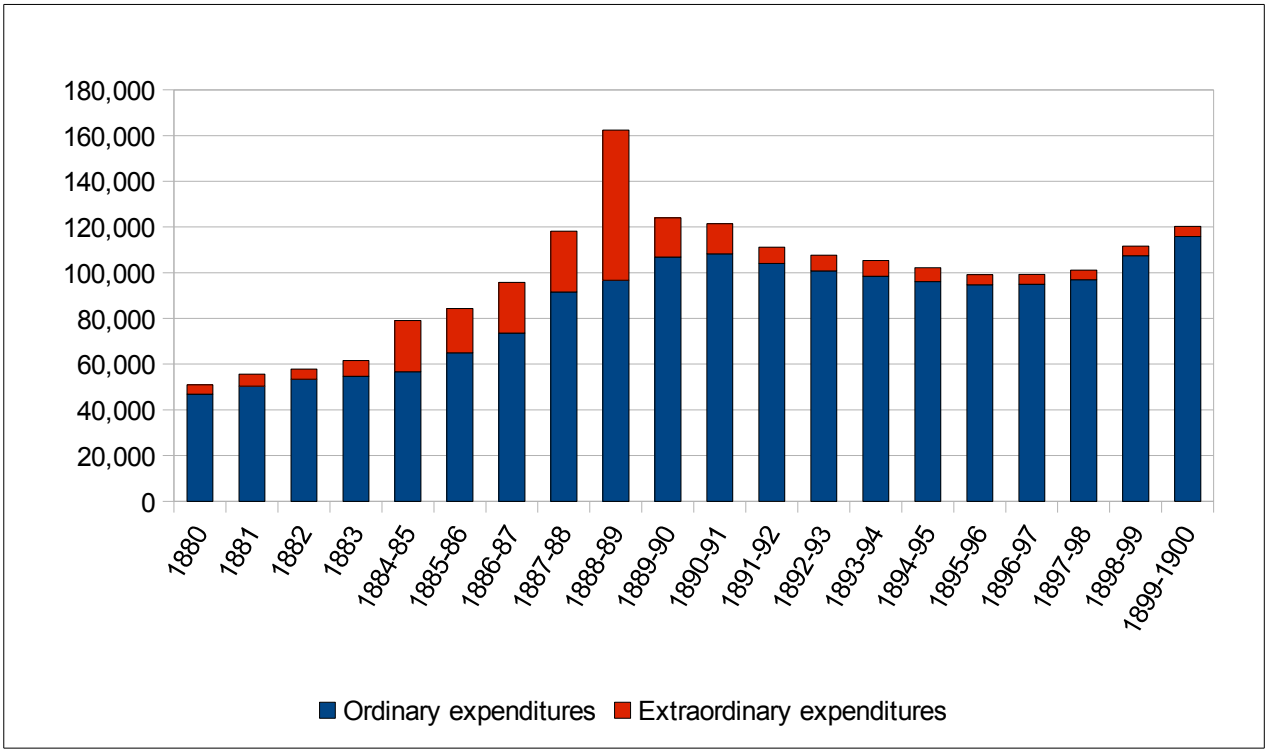
11 E. Cajano (ed.), *Il Sistema dei Forti Militari a Roma* (Roma, 2006) offers a detailed description of the fifteen forts erected around the city.

12 G. Rochat and G. Massobrio, *Breve Storia dell'Esercito Italiano dal 1861 al 1943* (Torino, 1978), 112-113.

13 F. Crispi (edited by T. Palamenghi-Crispi), *Politica Interna. Diario e Documenti*, (Milano, 1924), 189.

expenditures alone doubled in the course of the 1880s, from around 50 million to 100 million Lire.

Figure 4.1: Italian naval budget, 1880-1900 (in thousands of current Lire).



Source: *Raccolta delle Leggi e dei Decreti del Regno d'Italia*, various years.[14]

Around 1888, the Italian economy entered a period of economic slowdown, characterised by a serious crisis of the banking and construction sectors.[15] Government expenditures were cut across the board, and naval expenditures did not escape. The cuts, however, occurred in a different way from that of the late 1860s. In that period, both extraordinary and ordinary expenditures were cut. This time, extraordinary expenditures bore the core of the cuts: from 1884 to 1889 they had averaged 15-18 million Lire a year, after 1891 they accounted for around 5 million Lire a year. Ordinary expenditures, in contrary, were less hit and they never fell to less than 95 million Lire a year during the decade. The expansion of the 1880s had transformed the Navy: the more numerous and larger ships which had been introduced required more resources to be maintained in operation, more seamen had been enlisted, and arsenals enlarged. Therefore ordinary expenditures could be

14 In 1884 the government budget moved from being based on solar years, to be divided in periods going from 1 July, to 30 June of the following year. The parliament approved a special half-year balance covering the first six months of 1884 which, for reasons of consistency, is not included.

15 G. Toniolo, *Storia Economica dell'Italia Liberale 1850-1918* (Bologna, 1998), 139-157.

reduced only if the size of the fleet was significantly reduced, something which did not occur. The decline lasted until 1892-93 and naval expenditures stagnated until 1896-97. The situation was reversed at the end of the decade when the naval budgets started again to grow, a trend which continued to 1914. The expansion was again dominated by ordinary expenditures which were increased of 20 million in the years from 1897-98 to 1900-01.

4.2 *The creation of Terni.*

Benedetto Brin held the position of Minister for the Navy from 1884 to 1891. As it has been said above, while he was in office naval spending grew from 80 million Lire to 160 million in 1888-89. Whereas in the previous ten years extraordinary expenditures had represented just a small share of the budget, during Brin's tenure, extraordinary expenditures became much more significant, climbing to a proportion of the total expenditure which had not been seen since the early 1860s. In 1887 the Parliament approved a multi-year law providing 85 million Lire for naval construction (37 million), purchases of guns and torpedoes (29 million) and improvements to the arsenals (19).[16] Brin used the large amount of resources available to reshape the Italian Navy.[17] The Navy was significantly enlarged: the number of seamen was increased from 12,000 in 1880 to more than 20,000 in 1890; at the same time the combined displacement of the Navy doubled from 158,000 tons to 312,000 tons.[18] Brin, who had designed the large battleships *Duilio* and *Dandolo* during the 1870s, favoured the introduction of large, technologically advanced, powerfully armed, fast capital ships as the most effective way to check the French Navy: while France could count on a larger fleet, a screen of qualitatively superior Italian warships could offer a high-sea defence of the Italian costs, along which lay major industrial regions and strategic railways.[19] Consequently, a series of new powerful battleships were built to form the core of the Italian Navy, while smaller crafts such as torpedo boats and cruisers entered into service as auxiliary ships. Brin's preference for large battleships, regardless of whether such a strategy was coherent with the economic resources of the

16 'Nuove Spese Straordinarie per la Marina negli Esercizi dal 1887-88 al 1896-97 per la Somma di Lire 85 Milioni", Law 10 March 1887.
17 F. M. Baratelli, *La Marina Militare Italiana nella Vita Nazionale* (Milano, 1983), 162.
18 I. Ceva, 'Forze armate e società civile dal 1861 al 1887', in *1861-1887. Il Processo d'Unificazione nella Realtà del Paese. Atti del L Congresso di Storia del Risorgimento italiano (Bologna, 5-9 novembre 1980)* (Roma, 1982), 347-355.
19 E. Ferrante, *Il Pensiero Strategico Navale in Italia* (Roma, 1988), 13-27.

country, influenced Italian naval thinking until the Second World War.[20]

The reason why the Italian governments were able to finance such a naval policy was simple: the economy was growing. Despite cereal farming suffered from the competition of non European producers, the cultivation of other crops such as lemon and grapes offered good returns. Industry was going through a phase of vibrant expansion. In 1883 the forced circulation of paper money, or "corso forzoso", that is the suspension of the possibility to exchange notes into gold, was revoked and the country returned to a *de facto* gold standard. This increased the confidence in the Italian currency and, as a result, foreign capital flowed into the country. The increased availability of capital generated a strong growth of investments, especially in industry,[21] and also stimulated real estates and financial activities. The positive economic trend translated into higher government revenues, with public expenditures (excluding railways investments) growing by 34% from 1882 to 1887.[22]

In 1880 the Italian parliament approved the creation of a committee of inquire on shipbuilding and maritime trade which was chaired by Paolo Boselli, an MP from Savona and a leading supporter of shipbuilding interests in parliament (and future Prime Minister during the First World War).[23] The conclusions of the committee were published in seven volumes in 1882. Among other topics, the committee addressed the problem of whether the government should support shipbuilding and engineering firms. It concluded that the government, using the contracts awarded by the Navy, could play a decisive role in helping the national industry to develop and modernise itself. The commission thus suggested that the Navy should reserve the construction of the hulls of new vessels to private yards, sell some of its own yards and focus the activities of the remaining ones on repairs and maintenance.

Stimulated by these conclusions, the Minister for the Navy Ferdinando Acton established in 1882 a "Commission for the mechanical industries and shipbuilding". The chairman of the

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20 During the 1930s, the Italian Navy concentrated the majority of its budget on building or modernising battleships, G. Giorgerini, *Da Matapan al Golfo Persico. La Marina Militare Italiana dal Fascismo alla Repubblica* (Milano, 1989), 98-99.

21 E. Corbino, *Annali di Economia 1881-1890* (Milano, 1982), 332 offers a critical assessment of the abolition of the "corso forzoso". On the financial boom of the 1880s, V. Zamagni, *The Economic History of Italy 1860-1990* (Cambridge, 1993), 141-143; for its effect on banking A. Confalonieri, *Banca e Industria in Italia, 1894-1906*, vol. 1 (Milano, 1974), 174-198. The best assessment of the links between international financial cycles and the Italian economy before 1914 is S. Fenoaltea, *L'Economia Italiana dall'Unità alla Grande Guerra* (Roma-Bari, 2006), 77-122.

22 G. Brosio and C. Marchese, *Il Potere di Spendere. Economia e Storia della Spesa Pubblica dall'Unificazione ad Oggi* (Bologna, 1986), 178.

23 G. Barone, 'Lo Stato e la Marina Mercantile in Italia (1881-1894)', *Studi Storici* 15 (1974), 624-659. R. Romanelli, 'Boselli, Paolo', *DBI*.

commission, and the driving force behind it, was Benedetto Brin.[24] The commission had the task of surveying all the major industrial establishments in Italy and to assess which of them were in the position to undertake works which, until then, had been awarded to foreign firms. The final report of the commission offered a quite negative assessment. In Italy there were two major engineering districts: one in Naples and the other in Genoa. In neither of them, however, were firms capable of manufacturing high quality products at prices competitive with imports. According to the commission two major problems were responsible for this. First, the cost of raw materials and semi finished products was too high because they had to be imported: Italy's production of coal was negligible, and also the steel and iron industry was far from being developed. The cheapness of the workforce only partially compensated these disadvantages. The second problem was the lack of productive specialisation among firms caused by limited and erratic demand: each engineering and shipbuilding firm was forced to produce too many different products – naval engines, boilers, railways engines and carriages, industrial machineries, etc. without specialising in any. This meant that firms could not obtain economies of experience and were dependent of foreign designs and technology. Whereas Italian engineering firms had no problem in satisfying the local demand for small and medium mechanical products, at the present state they were in no position to undertake large and complex productions competitively.

The commission suggested that the government could offer contracts for hulls, naval engines and machinery to the few largest Italian companies to help them to specialise and strengthen their operations.[25] This was not enough, though. The commission concluded that, "what is missing [in Italy] is a large steel plant able to supply without restrictions all the material required by the Navy".[26] The final report was published only in 1885, but Brin, who in 1884 was back as Minister, had already taken decisive steps to increase the share of orders coming to Italian-based companies. This was the cornerstone of Brin's strategy, which was much more than a simple change in procurement: Brin understood how industrial development and technological innovations were affecting international relations. Military technology was advancing at a rapid pace. Naval warfare had changed beyond recognition in just two decades. As a consequence, economic and technological factors were becoming pivotal in the balance between powers. His personal training as an engineer, his first-hand knowledge of foreign naval technology, his long experience as a

24 E. Guaita, 'Alle Origini del Capitalismo Industriale Italiano: la Nascita della Terni', *Studi Storici* 11 (1970), 303.

25 P. Ferrari, 'Stato e Sviluppo Industriale, il Ministero della Marina 1884 – 1914', *Italia Contemporanea* 197 (1994), 687. See also, L. De Rosa, *Capitale Straniero nell'Industria Meccanica del Mezzogiorno 1840-1904* (Napoli, 1968), 125-127.

26 *Relazione della Commissione per le Industrie Meccaniche e Navali* (Roma 1885), 44.

bureaucrat assigned to liaison with private firms, all contributed to make Brin aware of the interplay between industrial growth and military power, of the changing nature of sea power, of how vessels and naval ordnance were becoming more expensive and sophisticated.[27]

While in the past, the strength of a nation was determined by a numerous army and a large fleet, now, in an industrialized world, the cornerstone of naval strength of a country was the capability it had to build and supply an effective and modern military machine. If Italy wanted to achieve its ambitions to be a leading power in Europe, it had to strengthen its economy and its armaments industry. Obviously, the continuous reliance on foreign suppliers weakened the Italian position, as Brin stated clearly during a parliamentary debate in 1884: "I believe that it would be an illusion to think of being a naval power, if we have continuously to resort to foreigners for the materials we need."[28]

Brin's assessment of the key role played by foreign suppliers was beyond dispute. The Italian Navy was buying abroad all the armour plates and all the large pieces of ordnance for its vessels. For instance, in 1877 the armour plates for the battleships *Duilio* and *Dandolo* were purchased from Schneider in France, for 10,559,295 Lire (1,800 Lire a ton).[29] In 1881 and 1882, additional orders were place in Britain with the Cammell and John Brown for 900 tons of iron deck armour for the battleship *Italia* at a price "between 1,900 and 2,000 Lire a ton".[30] These arrangements were clearly problematic, considering how strained were the relationships with France. In 1884, for instance, the Navy needed to order armour plates for the battleships *Lepanto* and *Ruggero di Lauria* as soon as possible to avoid delays in construction. Brin thus wrote to Pasquale Mancini, Ministry for Foreign Affairs to know if "it would be possible to order so important supplies of a military nature from French [i.e. Schneider] and British firms [i.e. Cammell and John Brown]; that is if you could assure that, for the next year, there will be no danger of running into difficulties which could cause the seizure of the supplies." Mancini replied that "nothing prevents ordering armour plates from the British firms", but he stressed that orders to Schneider could be justified only if there was no alternative way to avoid slowing down the construction of the vessel.[31] The French government could stop the delivery of plates ordered in France at any moment, and a blockade by the French Navy could easily delay imports from Britain.

27 M. Gabriele, *Benedetto Brin* (Roma, 1998), 8-10 and 34-36.
28 Camera dei Deputati. *Atti Parlamentari, Discussioni*, vol. 10, 10191.
29 *Inchiesta Parlamentare sulla Marina Mercantile* (Roma, 1882), vol. 5, *passim*.
30 *The Times* 30 October 1882, 11, and *Commissione Parlamentare d'Inchiesta sulla Regia Marina*, vol. 2, *Relazioni Speciali* (Roma, 1906), 59.
31 Museo Centrale del Risorgimento, Roma, MCRR/mancini/642/4/18.

At the same time, technical innovations occurring in the 1880s – the replacement of iron with steel for the manufacture of ordnance and armour plates as well as in shipbuilding, etc. – magnified the crucial role played by a reliable supply of steel which was something Italy lacked.

It was thus natural for Brin to offer his support to the project to create a state-of-the-art steel plant in Terni, in Umbria. The chief proponent of this venture was Vincenzo Stefano Breda, a former MP and businessman who was the president of the Società Veneta di Costruzioni, a company involved in construction and public works which relied heavily on governmental contracts.[32] Breda's vision was that of creating an integrated company able to produce pig iron from the iron ore excavated on the Elba island, and then transform pig iron into steel for both commercial and military purposes.[33] Such an ambitious project would have freed Italy from the need to import armour plates. Breda planned to expand a small metallurgic plant, the Cassian Bon company, which already existed in Terni. The reason why Terni was selected as the location is not completely clear. The records of the company about its first years are patchy, and what has been preserved does not clarify this point. Two reasons are usually regarded as having contributed. The first is the geographical location: Terni lies in the southern part of Umbria, far from this risk of being bombed by the sea. This was certainly an argument which pleased the Navy, although many other places were similarly far from the coast. A second reason which is usually noted is the presence in the region surrounding Terni of water falls which could be exploited for industrial purposes.[34] While later this happened, the use of water-generated energy during the first years was limited. As an industrial location Terni suffered, however, from a serious drawback: it was not well connected with the rest of the country. Being quite far from the major Italian ports in the North-West of the country, the cost in Terni of coal, iron ore and other raw materials which had to be transported there was higher than elsewhere. This problem affected also the price of the final products.

Enrico Guaita has suggested a different reason.[35] The Società Veneta di Costruzioni had recently purchased the majority of the capital of the Cassian Bon company.[36] The Società Veneta was also the main purchaser of Cassian Bon's major production: pig iron pipes for aqueducts. The Veneta, however, had recently brought to completion the major contracts for which it required such product. The decision to create the new steel works in Terni enlarging Cassian Bon plant could thus

32 F. Bonelli, 'Breda, Vincenzo Stefano', *DBI*.
33 Id., *Lo Sviluppo di una Grande Impresa in Italia: la Terni dal 1884 al 1962* (Torino, 1975), 19-23.
34 R. Covino, 'Nascita e Sviluppo di un'Impresa. L'Acciaieria di Terni: Uomini, Progetti e Tipologie d'Impresa', Id. and G. Papuli (eds.), *Le Acciaierie di Terni* (Milano,1998), 20.
35 Guaita, 'Origini', 304-7.
36 On Cassian Bon *La Società degli Alti Forni, Fonderie ed Acciaierie di Terni ed i Suoi Stabilimenti* (Terni, 1898), 11-14.

have been an attempt by the management of the Società Veneta to extricate their company from a difficult situation. Guaita himself, however, recognises that the origin of the company "is one of the more obscure moments of the history of the company", and that it is likely that a combination of various reasons concurred to the selection of Terni.

Whatever the reasons behind Breda's decision, on 10 March 1884, the shareholder of Cassian Bon voted to transform the old limited partnership into a joint-stock company named "Società degli Alti Forni e Fonderie di Terni' (SAFFAT) with the initial capital of 3,000,000 Lire, which was soon raised to 6,000,000.[37] Shares in the new firm were subscribed by the major Italian banks (Banca Nazionale, Credito Mobiliare and Banca Generale), plus by a group of wealthy financiers and aristocrats from Veneto (such as Baron Alberto Treves and Gaetano Romiati). Breda and the Società Veneta's major contribution were the assets of Cassian Bon, which were valued at 2,400,000 Lire. An assessment which, twenty years later, the Enquiry Committee on the Italian Navy which investigated the relationship between Terni and the Navy found to be excessive.

On 16 May the first contract between the Navy and the new company was signed. The Navy purchased 8,600 tons of armour, of which 4,700 had to be delivered by 1887, for 16,000,000 Lire. The government immediately paid Terni 3,200,000 Lire as anticipation of the future delivery to help set up the plant. Terni was required to provide plates "of the same quality of the ones manufactured by Mr. Schneider" for a price which "should not be grater than that which is possible to obtain from foreign firms".[38] Terni's management decided to install Martin-Siemens open hearth furnaces, the first in Italy.[39] Martin-Siemens process was particularly suitable for making special steel because it took several hours to melt and refine a charge, and thus it gave time to monitor the process carefully.[40] This aspect became still more important when, in the 1890s, steel alloys were introduced and the possibility of altering the chemical composition of the metal became crucial. The company bought five 22 ton furnaces. The pace of investment was rapid: in December 1885 the company's capital was increased to 12 million Lire, and raised to 16 million Lire in October 1886. The company's board was also authorised to issue up to 16 million Lire in debentures to provide for the working capital needed to begin production.

Franco Bonelli has calculated that the advances on future works paid by the government

37 Id., 17.
38 *Commissione Parlamentare d'Inchiesta sulla Regia Marina. Relazione Preliminare* (Roma, 1905), 86.
39 G. Papuli 'Processi, Prodotti e Immagine', Covino and Papuli (eds.), *Acciaierie*, 72.
40 A detailed description of the Martin-Siemens process is in K. C. Barraclough, *Steelmaking: 1850-1900* (London, 1990), 142-146.

accounted for 19% of all the capital invested by Terni in its first ten years of operations.[41] It is not surprising, then, that the relationship between Terni and the government created a lot of controversy from the beginning: the Navy was paying a significant amount of money to a company whose works did not exist yet, and whose capacity to manufacture high quality plates was uncertain, to say the least. It is clear that for Breda it would have been much more difficult to realise his project without the support of the Navy. Breda's incentives, as well as that of all the other shareholders, are fairly clear: he was a shrewd businessman with plenty of connections among the political elite. He knew that the creation of a modern steel plant might potentially represent a very lucrative investment, especially if the Navy could be persuaded to award Terni orders for armour plates.

The Navy's paramount preoccupation was that to secure a domestic source of armour plates and ordnance forgings. Other attempts had been made in the past to create metallurgical plants for the manufacture of military goods, but with no concrete results: in 1873 the Parliament approved a law awarding the rights for the excavation of the Elba's iron ore deposits to Francesci Brioschi but he did not pursue his plan.[42] In 1878 (when Brin was Minister of the Navy for the first time) the government tried again to lure private investors to set up an iron works to satisfy the needs of the Navy by offering the right for the exploitation of Elba's mines, but, again, the project failed to attract any investor.[43] What this time was different was that the Italian Navy was enjoying an unprecedented increase in its budget: in 1884 the Navy was building four battleships – *Lepanto*, *Ruggero di Lauria*, *Morosini*, and *Andrea Doria* – and the armour plates for two of them still had to be purchased. Moreover, the Navy had already drawn up projects for two more battleships, and additional capital vessels were expected to be built in the future. The forecast consumption in the following years was of up 10,000 tons of vertical armour and 4-5,000 tons of horizontal plates. This volume of demand put pressure on traditional suppliers: the risk was that the entrance into service of the vessels under construction and of the planned ones might be postponed by delays in the delivery of armour plates from abroad. The additional capacity provided by a new Italian-based plant could address this problem. The magnitude of the expected orders, in addition, was substantial enough to make attractive to private interests setting up the new works,.

Inside the government bureaucracy, however, not everyone agreed with Brin. For instance, Giuseppe Mantellini, who from 1876 to 1885 was the head of the government legal service

41 Bonelli, *Terni*, 17.

42 Camera dei Deputati, *Convenzione per l'Accollo e l'Escavazione delle Miniere Terranera e Calamita nell'Isola d'Elba e per la Vendita del Minerale Escavato*. On Brioschi N. Raponi, 'Brioschi, Francesco', *DBI*.

43 Camera dei Deputati, *Erezione di Stabilimenti Siderurgici e per l'Affitto delle Miniere dell'Isola dell'Elba per Provvedere ai Bisogni della Marina e dei Lavori Pubblici*, 20 novembre 1878.

expressed doubts about the contract which the Navy had signed with Terni: he feared that "if this speculation will work, and let's hope God wants this, the company will enrich itself, and, if it does not work, and let's hope God this won't happen, the Navy will lose all or the majority of its advances".[44] Mantellini was concerned about what nowadays is called "privatisation of profits and socialisation of losses": in case the venture would prove successful, the profits would accrue to the firm's shareholders, while if it proved unsuccessful, the government would lose its money. Notwithstanding these criticisms, the Navy carried on with its plan. Breda had assembled behind him a powerful group of moneyed interests which enjoyed influence in parliament. What is more, military policy was an area into which central administration could exercise limited leverage and control.

In 1887 Terni was already on the brink of failure, before having delivered a single armour plate. The company had overstretched itself buying unprofitable coal and iron mines and had lost money hoarding raw material for fear of facing problems with their supply later on.[45] At the same time the management realised that additional investments were required before it would be possible to start production. Mismanagement, poor supervision and simple inexperience added to the final price tag. The company itself offered inconsistent estimates of the value of the works: the 1887 balance sheet of Terni gave to the plant, the machineries and the buildings a total value of 30 million Lire, while in 1888 the value of the plant alone was put at 19 million lire. In 1895, speaking to the Senate, Breda claimed that, not considering government's advances, the company had invested a total of 44 million Lire. Terni was rescued from its critical position by the Navy, which signed another contract (dated 15 December 1887) ordering 2,600 tons of plates and, in addition, advanced other 5,800,000 Lire to the firm, in anticipation of future deliveries. The problems facing Terni, however, were not immediately solved: "the firm, a few months after the 1887 contract, encountered new problems, and so asked the government for both new subsidies and the assurance of larger orders in the future".[46] Then in 1888 the Navy signed a third contract for 3,000 tons. As usual, Terni also received 3,000,000 Lire in anticipation of works it still had to begin. By the end of 1888 Terni had received 12 million lire from the Navy and had accumulated orders for 14,200 tons of armour plates.

Why did the Ministry of the Navy support Terni, despite the company's many problems?

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44 *Commissione Parlamentare d'Inchiesta sulla Regia Marina. Relazione Finale*, vol. 1, *Relazione Generale* (Roma, 1906), 117

45 Id.,120. On Terni's hoarding of pig iron B. Stringher, 'Gli scambi con l'Estero e la Politica Commerciale Italiana dal 1860 al 1910', Regia Accademia dei Lincei, *Ciquant'Anni di Storia Italiana*, vol. 3 (Milano, 1911), 36.

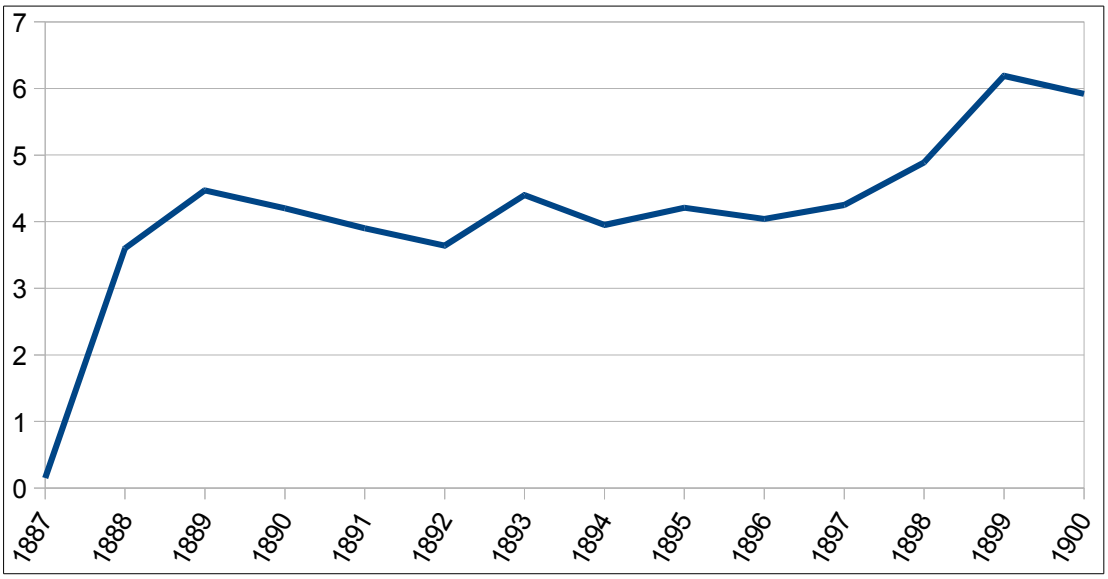
46 *Inchiesta sulla Marina. Relazione Preliminare*, 94.

Although the records are silent about this, it is possible to speculate that three reasons played a role. First, there was a strategic reason: if Terni collapsed, this would have slowed down the naval programme. Placing orders abroad for the large amount of plates required would have needed months-long negotiations with potential suppliers, and then waiting for several years before the delivery of the plates, a serious problem for the Italian Navy which had to counter the French naval expansion. Second, the failure of Terni would have had enormous political and economic consequences: the Navy would have became embroiled in a scandal which could damage its reputation. Only twenty years after Lissa this was something no Minister was willing to risk. Third, Terni's owed millions of Lire to the banking system and to the general public, through the debentures it had issued. If the company became bankrupt, this would send a shock wave through the economy at the very moment in which the business cycle was turning negative. While each single reason alone was not conclusive, combined they were decisive. Thus, as a result of Brin's decision to support Breda in the creation of Terni taken in the early 1880s, the Italian Navy ended up being locked into supporting the company despite its shortcomings and its poor performance.

The crisis experienced in 1887-88 had profound consequence on Terni. The ambitious plan devised in 1884 to create an integrated production cycle, from iron ore to steel passing through pig iron production, was given up. The plan to make pig iron in Civitavecchia was abandoned with the result that it was not produced in Italy for another twenty years. Simply speaking, Terni had not enough resources to finance all these developments. Moreover, it is questionable if Terni's management was up to the task of realising such a far-reaching scheme, considering the many problems experienced by the firm. Thus the steel made in Terni was obtained from pig iron bars imported from abroad. This fact, while not completely freeing Italy from the need to import foreign raw materials, certainly eased the strategic problems generated by the Italian naval expansion because pig iron could be imported from many countries, while special armour plates were manufactured only by a small number of companies. Finally, something should be said about Terni's final year's results (Figure 4.2).

Terni's operating profit floated around 4 million lire for the first 10 years of its operations, from 1888 to 1897. Admittedly, the regularity of the numbers issuspicious. It is impossible to rule out the fact that the firm's management massaged the balance sheet in order to present a rosier picture of the firm to bond holders and the public. There is no doubt, however, that the firm, after approaching bankruptcy in 1887, became profitable. From 1898 a more prosperous period started, which was generated by the resumption of naval construction which translated into more orders.

Figure 4.2: Operating profits of Terni, 1887-1900 (million current Lire).



Source: AST, FT, *Bilanci della Società Terni*, various years.

Dividends, however, were paid only in 1892 and from 1894 onward: depreciation covering the initial investments took a large share of the profits (from to 35% up to 300% of the annual profits, with an average of 40%) and financial costs accounted for another significant share of operating profits. Until 1895 the firm delivered in average 1,700 tons of armour plates every year, an amount which increased to 3,500 from 1896 onwards.[47]

The Italian Navy had strongly supported the creation of Terni because it wanted to be able to rely on a domestic source of high quality armour plates. Armour technology, however, evolved substantially in the years after 1884. Terni, thus, was faced with the problem of keeping pace with technological development. Before 1891 armour plates were either "compound" (that is made of a steel layer superimposed on an iron one) or made using forged steel, which Schneider had introduced in 1876. During the first years of its operations, Terni produced forged steel plates, following the technology developed by Schneider, its technical adviser. The Navy, however, was not completely happy with the final product: on 27 February 1889 the Ministry wrote to the firm pointing out that the horizontal plates (i.e. plates used to cover the deck of vessels) were of unsatisfactory quality: Terni was employing up to 25% of metal scrap to make the plates, limiting the amount of puddled metal to 50% of the total. Such a solution allowed the company to reduce its costs because it could use the waste material coming from the manufacture of vertical plates, but the

47 Bonelli, *Terni*, 315.

final product was weaker than if only high quality metal had been used. The Ministry asked Terni to redress this mistake immediately. While the Navy could compromise on price and advances, it was not ready to do so on quality.

The early 1890s saw a wave of innovations in armour plate manufacturing. In 1890 Schneider introduced nickel-steel plates, and in 1892 the first trial in Europe of Harvey plates highlighted their superiority. Once again, the Italian Navy was facing the problem of gaining access to the most up-to-date products.[48] In 1894 the Navy approached Terni with an order for 9,000 tons. It put the firm under pressure to undertake the production of plates according to the Harvey system. In order to to do, the firm had to invest extra resources needed to undertake the time-consuming and complex hardening process. Once again the Navy supported Terni by advancing the firm 1,000,000 Lire. Terni did not acquire the patent for the Harvey process, however. The records do not contain evidence of any communication between Terni and the Harvey syndicate. It is therefore impossible to rule out that Terni tried to acquire the right to use the patent but failed to arrive at an agreement with the syndicate. At the end Terni developed its own system, which it patented.[49] Terni's claim to have developed an original innovation, however, seems doubtful. Terni's patent for cementing plates differed from Harvey's in just one point: during the process, while one face of the plate was hardened, the other was softened keeping it in contact with sand. Unsurprisingly, in 1901 the Harvey syndicate sued Terni accusing it to violating its patent. The controversy was resolved when Terni agreed to pay a million Lire to join the syndicate.[50]

The controversy on the Harvey patent is noteworthy because it highlights two key points: on the one side it reinforces the view that for the Italian Navy the paramount issue was that of technical quality. To obtain this, it was ready to keep supporting Terni as long as it was needed. On the other side, the Harvey-Terni controversy clearly illustrated to the fact that Italian armaments firms still needed to import know-how and technology from abroad. Terni had certainly achieved the ability to satisfactorily employ the most up-to-date foreign techniques, but it lacked the ability to autonomously develop innovations.

48 The Italian Navy was well aware of the value of Harvey technology. In 1893 the Rivista Marittima published a detailed analysis of the properties of the new plates: R. Bettini, 'Corazze per Navi', *Rivista Matittima* 26, 443-445.

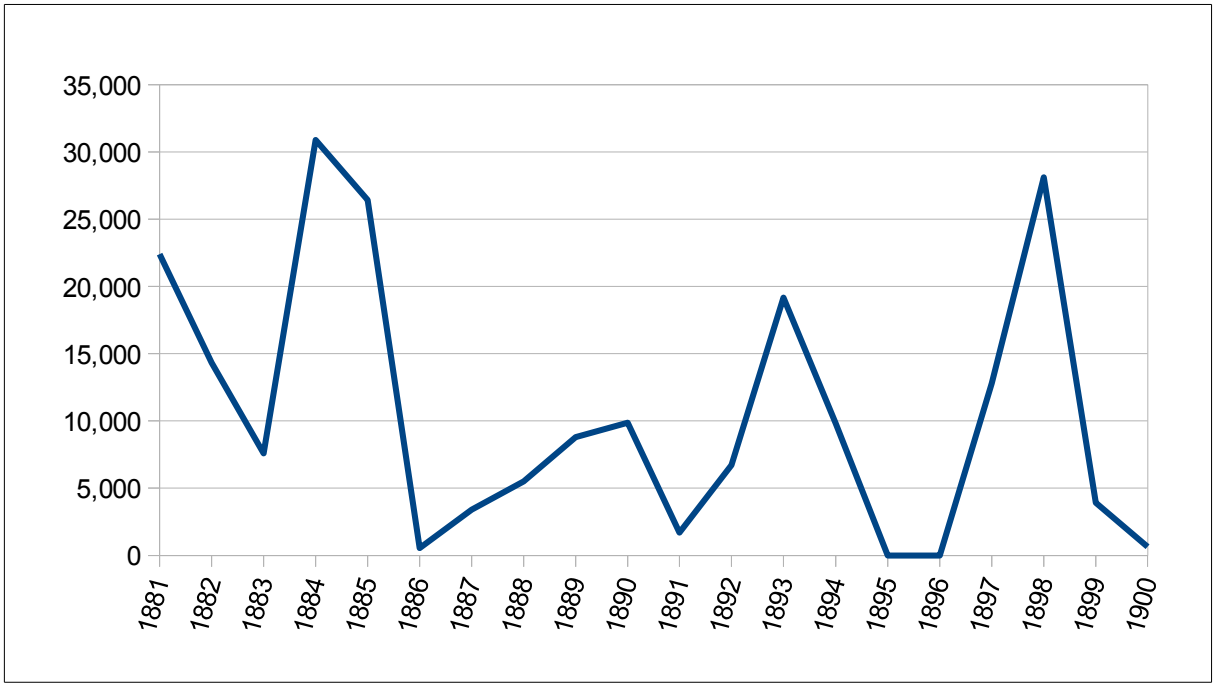
49 *Inchiesta sulla Marina. Relazione Preliminare*, 106

50 Testimony of Ippolito Sigismondi, general director of Terni since 1895, and previously Director General for Naval Construction at the Ministry of the Navy, to the Enquire Commission on the Navy in 1905: *Inchiesta sulla Marina. Relazione Generale*, vol. 2, *Relazioni Speciali*, 91.

4.3. *Naval shipbuilding.*

The creation of Terni and Pozzuoli was a decisive shift in the way in the Italian Navy obtained key military inputs: instead of having to rely on imports, now large guns and armour plates were domestically manufactured. Fitting these inputs and building warships was the task performed by a handful of private shipbuilding firms, and of the public arsenals in Spezia, Castellammare, Taranto, and Venice.[51] In chapter II it has been explained how during the 1860s and 1870s a small group of Italian firms had started to supply the Italian Navy with naval engines and other mechanical components, partially replacing imports from abroad. In addition, also naval shipbuilding had started. During the 1880s and 1890s this process of substitution of imports continued, although the Navy did not stop to buy abroad, and used its own arsenals to built the largest capital ships. The increased sophistication of the Italian armaments industry became evident at the end of the century, when Ansaldo and Orlando were able to sell several cruisers to foreign governments.

Figure 4.3: Total displacement started by year, 1881-1900 (in tons).



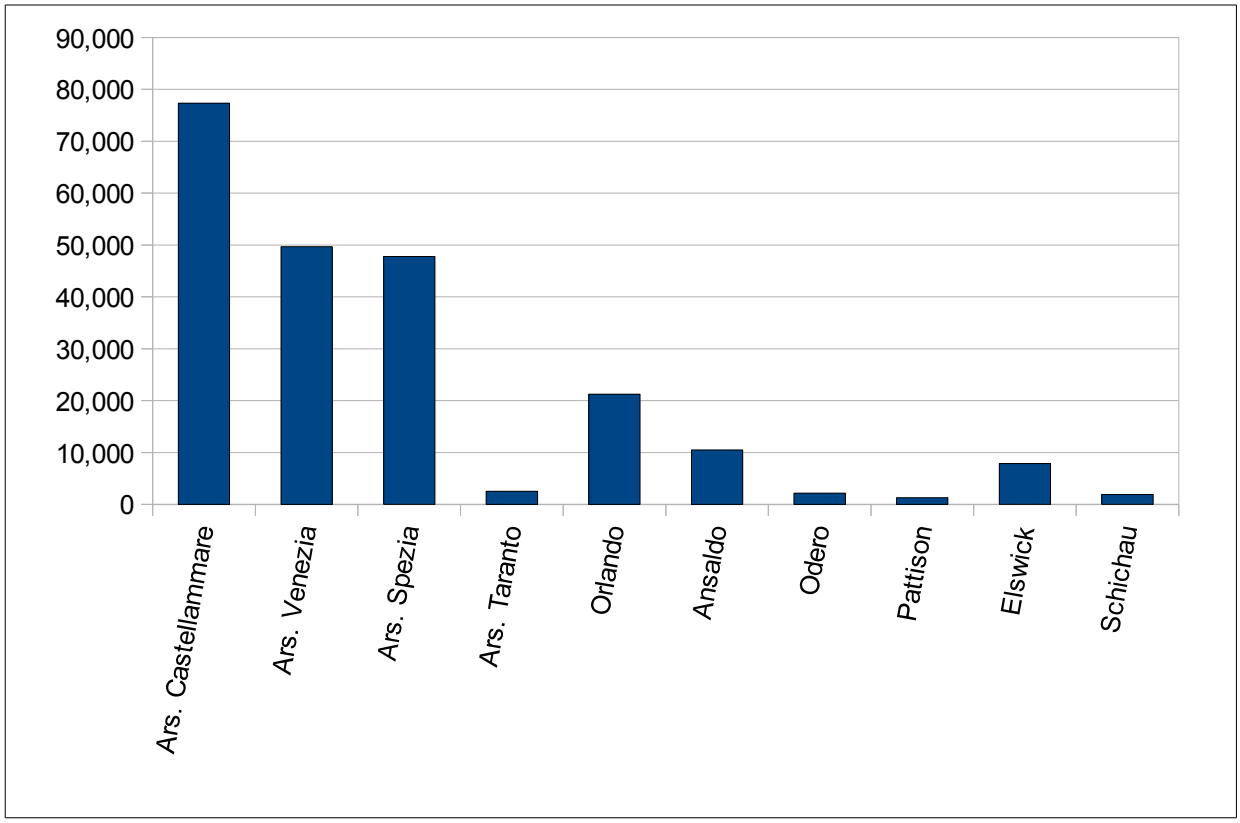
Source: G. Giorgerini, and A. Nani, *Almanacco Storico delle Navi Militari Italiane (1861-1995)* (Roma, 1996), *passim.*

51 D. J. Grange, 'Sur les Arsenaux de la Marine Italienne au Début du Siècle', Istituto di Storia Economica, Università di Torino (ed.), *Studi in Onore di Mario Abrate*, vol. 2 (Torino, 1986), 493-511.

As it has been said at the beginning of the chapter, the Italian Navy underwent a significant process of modernisation during the 1880s. The additional resources devoted to the naval budget translated into supplementary construction. Figure 4.3 shows the total displacement of ships of at least 300 tons started each year in the period 1881-1900.[52]

The first half of the 1880s was a period in which many vessels were started (in 1885 alone eleven ships were laid down). This explains the smaller values registered in the second half of the decade: yards, both private and public were still busy completing previous orders. The first half of the 1890s saw a reduction in new construction: only three cruisers laid down, all of them in public arsenals. There was a significant rebound in the late 1890s. Figure 4.4 shows the data on new construction divided by yards, both public and private, Italian and foreigners.

Figure 4.4: Total displacement launched for the Italian Navy in the years 1881-1900, divided by suppliers (in tons).



Source: see figure 4.3.

In the years 1881-1900, the majority of the vessels, especially capital vessels, were built by

52 Gunboats *Castore* and *Polluce* (laid down in 1887 and finished in 1889; displacement of 330 tons each) are not included: they were purchased from Armstrong by the Army and only later they were taken over by the Navy.

the Navy in Castellammare di Stabia (77,313 tons), Venice (49,696 tons) and Spezia (47,775 tons). Taranto's yard built only 2,538 tons because shipbuilding began there only in 1893. Among private yards, there were only four firms which the Navy regarded as capable of building and fitting ships: Orlando (in Leghorn), Ansaldo (in Sestri Ponente), Odero (which had two yards, one in Genoa, the other in Sestri Ponente) and Pattison (in Naples).[53] Orlando doubled Ansaldo in terms of tonnage built (21,258 tons vs. 10,477 tons) for the Italian Navy (if ships built for foreign governments would be added, Ansaldo would rank first, with around 46,000 tons built versus Orlando's 37,000 tons).[54] The other two yards which worked for the Navy, Odero (based in Genoa) and Pattison (based in Naples) built much less.[55] Orlando and Ansaldo owned the largest and the best equipped yards, and therefore they received more orders and for larger ships, such as cruisers, medium-sized gunboats, transport ships, etc. At the opposite Pattison and Odero received orders especially for smaller non-military vessels, such as pontoons, tug boats, dredgers, etc. In the case of the two smaller yards it is therefore difficult to consider their production as specifically military in nature. Finally, Elswick prevailed among foreign firms. It built 7,855 tons, while the German Schichau-Werke company ranked second, with 1,920 tons. Schichau only supplied torpedo boats and, later, destroyers. The continuous relevance of the public arsenals is testified to by the increasing number of workers they employed: from around 8,000 in 1880, to 18,000 in 1890, a value which remained unchanged until the end of the decade.[56] Once again, it is important to stress the fact that public arsenals were building vessels by assembling parts (naval engines, armour plates, guns, but also forgings, shafts, rudders, etc.) which, in the majority of cases, were supplied by private firms.

Figure 4.5 shows the temporal dynamics of the purchase of vessels from private suppliers, highlighting the impact that trends in military spending had on firms. Orders for complete ships grew during the 1880s, when the capacity of arsenals was fully employed building battleships, leaving room for private yards to build cruisers and small vessels. The hiatus in launching lasting until the late 1890s is explained by the fact that several cruisers the Navy had ordered from Ansaldo and Orlando were sold abroad, and replaced by other vessels, which were delivered later. It is important to notice that larger vessels required years to be completed. So, for instance Orlando's

53 *Inchiesta sulla Marina*, 'Elenco delle Ditte Idonee per Forniture alla Regia Marina', 37.

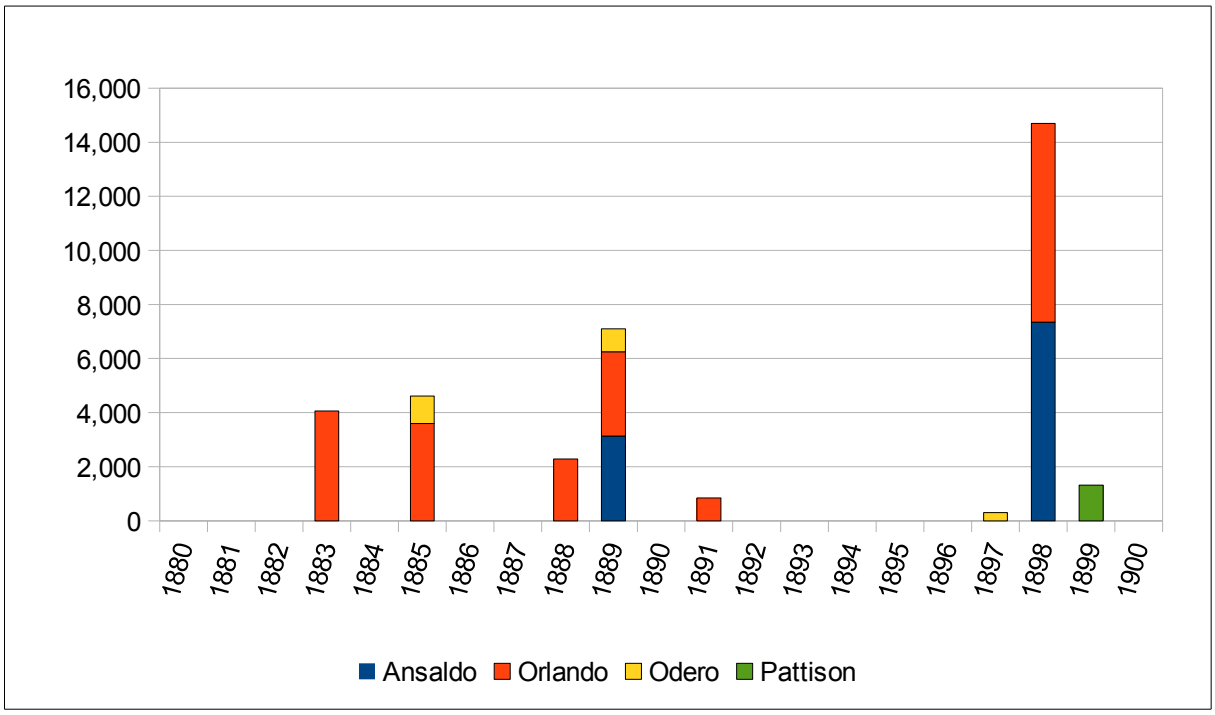
54 Apart from the two *Garibaldi* cruisers, Orlando sold abroad the gunboat *Bascir* to Morocco in 1890, and the cruiser *Adamastor* to Portugal in 1896, *I Fratelli Orlando e le Costruzioni Navali per l'estero* (Livorno, 1898), 15-16.

55 Little has been written on Odero's yard, see G. Doria, *Investimenti e Sviluppo Economico a Genova alla Vigilia della Prima Guerra Mondiale*, vol. 2, *1883-1914* (Milano, 1973), 28-29, 36 and 124; on Pattison see De Rosa, *Iniziativa Straniera*, 214-15 and 223-25.

56 Camera dei Deputati, *Disposizioni Relative alle Costruzioni Navali e agli Operai degli Stabilimenti Marittimi*, 15 November 1900. Other parliament documents report slightly different numbers, but the differences are very small.

yard was still working in 1885 on the battleship *Italia*, which had been ordered in 1876.

Figure 4.5: Displacement of ships launched for the Italian Navy by Italian private yards in the years 1881-1900 (in tons):



Source: see figure 4.3.

Orders awarded to foreign yards were motivated by a different reason. They represented only 3.8% of the total tonnage built or bought by the Navy in these years. What the Navy bought from Elswick and Schichau was not quantity, but quality. Elswick with the Chilean ship *Esmeralda* (laid down in 1881) had introduced a new kind of vessel: a steel-hulled, fast, lightly armed, cruiser which relied on the speed generated by its compound engine rather than on armour plates for its defence.[57] The Italian Navy coveted this design: *Esmeralda* was far superior to the cruisers it had in service. The light armour meant that the supply of plates was less a problem. The Italian Navy decided to buy directly from Elswick a cruiser and to use it as a model to be replicated by Italian yards. Four additional cruisers were built according to the same design, two in arsenals, and two by Orlando.[58] Once again, technical innovations in design and construction developed abroad were acquired and, later, reproduced in Italy. The same motive – acquired advanced technical features

57 P. Brooks, *Warships for Export: Armstrong Warships, 1867-1927* (Gravesend, 1999), 44-5.
58 G.Giorgerini and A. Nani, *Gli Incrociatori italiani 1861-1964* (Roma, 1964), 152.

which were later could be incorporated in Italian-built ships – was behind the purchase of the other two cruisers from Elswick: *Dogali* (laid down in 1885 and delivered in 1886) was the first cruiser to be fitted with a triple expansion engine, and *Piemonte* (laid down in 1887 and delivered in 1889), was the first cruiser to be armed only with the quick-firing guns which Armstrong had developed.[59]

A similar pattern, from purchase abroad to domestic production, can be found in the case of destroyers, a new kind of vessel which started to be introduced at the end of the 19th century as countermeasure to torpedo boats. At the end of the century the Italian Navy ordered several destroyers from the German firm Schichau, which was recognised as among the best designer of small warships in Europe.[60] The next step was ordering destroyers from Pattison,[61] which built the five small ships of the *Nembo* class on the basis of the designs purchased from the British firm of Thornycroft. The final step in the process were the destroyers of the *Soldato* class, which were designed and built by Ansaldo from 1905 onwards.

The data presented above show that Ansaldo and Orlando were the largest private firms involved in naval construction in Italy. Both firms took advantages of the opportunities generated by the Italian naval expansion in the 1880s and 1890s. They followed, however, different strategies. In 1882 Carlo Bombrini, the major shareholder of Ansaldo and director of the Banca Nazionale died. The firm was taken over by two of his sons, Carlo Marcello and Giovanni. Their first task, after buying out the 8% of the capital of the firm still owned by the heirs of the other original shareholders was to arrive at an understanding with Giulio Belinzaghi, the new general director of the Banca Nazionale, about the outstanding debt Ansaldo had accumulated with the bank.[62] Now that Bombrini's influence had disappeared, the bank wanted to close its unfortunate relationship with the firm. After a long negotiation the new shareholders secured a favourable agreement with Belinzaghi. The bank received a payment of 10 million Lire and agreed to forfeit all its residual claims (which amounted to additional 6-7 million Lire).[63] Probably Belinzaghi, who was himself involved in many financial ventures and real estate speculations, preferred to avoid too much publicity on a less than transparent page in the bank's history.

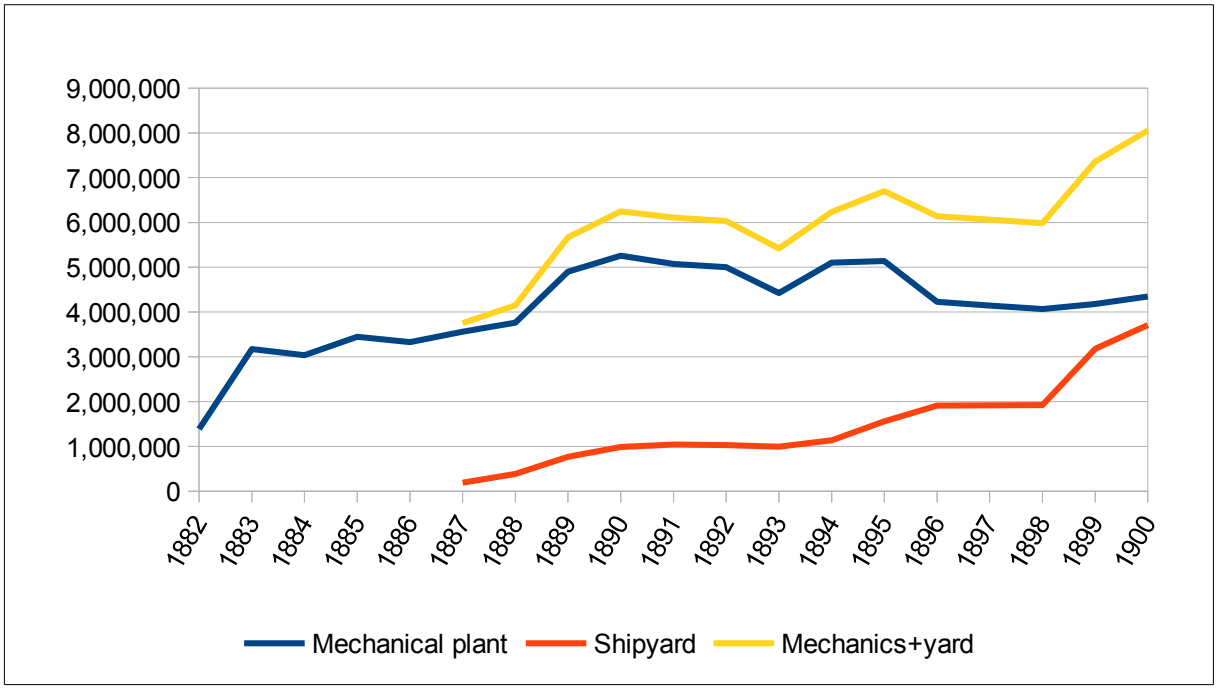
The soaring naval budget, as well as the renewal in 1885 of railways franchises, opened the possibility of turning around the firm. The new owners decided to heavily invest in new machinery

59 P. Brooks, 'Armstrong and the Italian Navy', A. Preston (ed.), *Warship 2002-2003* (London, 2002), 101-108.
60 On Schichau's naval activities, see L. U. Scholl, 'Schichau, Ferdinand', *NDB*.
61 Not accidentally Pattison received these orders in a moment in which the Italian government was concerned about the economic development of Naples and its surrounding region, S. Prezioso and G. Servidio, 'Industria Meridionale e Politica Industriale dall'Unità ad Oggi', *Rivista Economica del Mezzogiorno* 25 (2011), 561-64.
62 N. Foà, 'Belinzaghi, Giulio', *BDI.*
63 AFA, FBP, 4/2 *Memoriale di Giancarlo Ageno*.

to expand the firm so that Ansaldo could undertake larger, and hopefully more profitable, contracts.[64] Until that moment, Ansaldo activities had been mainly limited to engineering productions, especially large naval engines, carried on at the Sampierdarena plant. The firm had also produced railway engines, carriages and industrial machinery of various nature for the civilian market. Shipbuilding had represented a secondary activity: the firm did not own a proper yard until, in 1886, it bought for 335.000 Lire the shipyard of the Cadenaccio brothers in Sestri Ponente (the town neighbouring Sampierdarena).[65] The expanding naval budget meant that Ansaldo could expect to receive orders from the Navy for small and medium vessels, if not for the largest battleships. Ansaldo's expertise in naval engines allowed for synergies between the engineering activities and shipbuilding, strengthening the firm's position. During the first ten years of its activity, Ansaldo's yard built many different kinds of ships: torpedo boats (based on Schichau design) for the Italian Navy as well as wooden sailing ships for local merchants. The largest naval vessels it made before the 1890s were two light cruisers, *Minerva* (843 tons) and *Liguria* (2,260 tons), which was based on the design of the Elswick–made *Dogali.* They were both laid down in 1889 and delivered in 1893 and 1894 respectively.[66] However, until the second half of the 1890s, mechanical activities were still the core business of the firm. Anna Maria Falchero has calculated that in this period naval engines and boilers accounted for 58% of Ansaldo's revenues coming from contracts awarded by the Navy, with naval construction representing 38%.[67] To reinforce its position in naval engines production, and acquire the most up-to-date know-how, Ansaldo reached an agreement with the British firm Maudslay in 1886 to make use of the designs developed by it in exchange of a fee. This agreement resulted immediately in the order of the 19,500 HP engines of the battleship *Sicilia*, evidence of the fact that the Navy still regarded British products as superior, at least in the field of the very large engines.[68] Figure 4.6 shows the book value of the firm's engineering plant and yard (that of other, smaller plants, is not included), allowing us to gauge the investments trend and the growing importance that shipbuilding was acquired in the course of the 1890s.

64 *Notizie sullo Stabilimento Meccanico e di Costruzioni Navali Gio. Ansaldo & Co. di Sampierdarena* (Torino, 1884), 22-25.
65 E. Gazzo, *I Cento Anni dell'Ansaldo 1853-1953* (Genoa, 1953), 317, 322 and 324.
66 For a complete list of all the ships built by Ansaldo A. Giuntini, 'Dati Statistici', Giorgio Mori (ed.) *Storia dell'Ansaldo*. Vol. 2, *La Costruzione di una Grande Impresa, 1882-1903* (Roma-Bari, 1995), 238-241.
67 A. M. Falchero, 'Le Strutture e l'Evoluzione dell'Ansaldo', Giorgio Mori (ed.) *Storia dell'Ansaldo*, 51.
68 AFA, FBP, b.8, f. 2.

Figure 4.6: estimated value of Ansaldo's mechanical plant and yard, 1882-1900 (in current Lire).

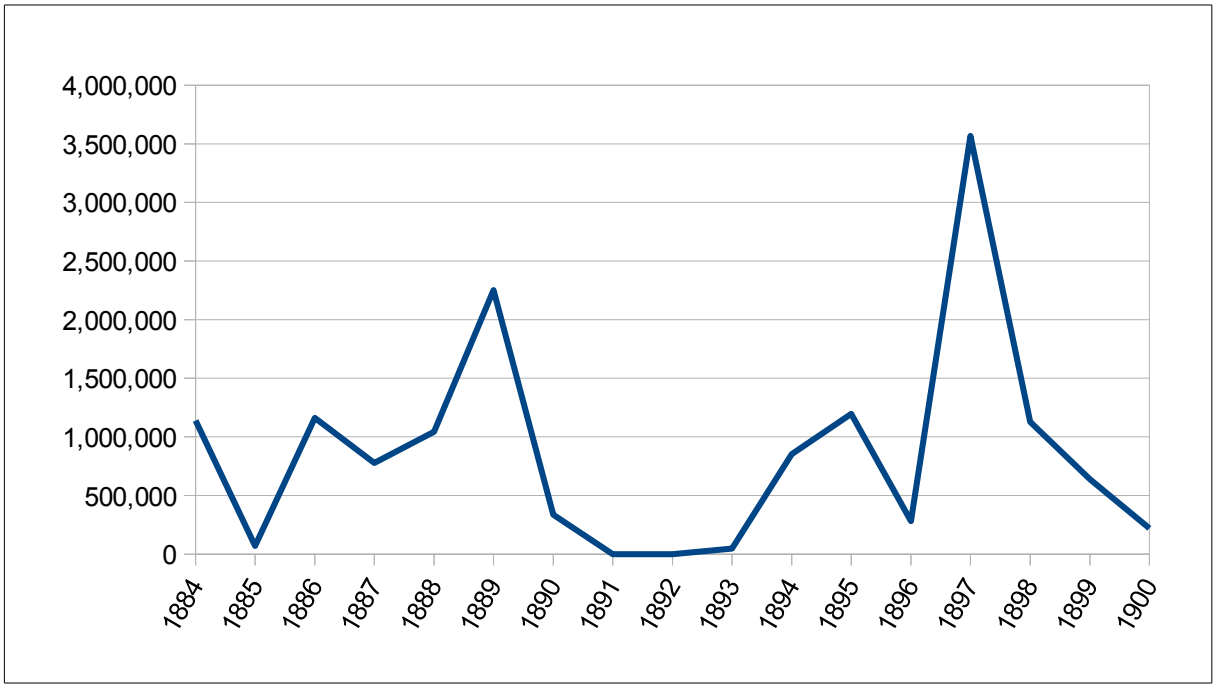


Source: AFA, FP, SSM bis 2/3

When the new shareholders took control of the firm in 1882, they immediately undertook investments to modernise and enlarge the mechanical plant after years of forced underinvestment. The value tripled in two years, from one to three million Lire. In the course of the 1880s the rate of investment slowed down, but it was still positive. In 1889 there was another jump, when the value of the mechanical plant increased by one million to 5 million lire. The firm had received several orders for naval engines and it had to expand its works with additional machines and spaces. In the course of the 1890s the decline and stagnation of the Italian naval budget translated into a reduced budget for naval construction. Ansaldo's activities suffered from this, and during that decade the value of the mechanical plant declined to 4 million Lire, the same value it had in 1888. Whereas the engineering plant suffered from a period of stagnation in the 1890s, Ansaldo's yard expanded considerably in the same period. The firm had already improved the small Cadenaccio yard, but the real growth occurred in the second half of the 1890s, with the sale of several cruisers abroad. By the end of the century, the value of the yard stood at little less then 4 million Lire, a value only 600,000 Lire inferior to that of the engineering plant. Data on the firm's workforce confirm this dynamic. By 1889, Ansaldo employed more than 2,000 workers, of whom 1,600 works in the engineering plant.

In 1892 they had reduced to 800. Similarly, the shipyard's workforce felt from 600 in 1890 to 380 in 1893. In 1897, the engineering plant employed 1,480 workers, while the yard had 1,250, an additional testimony of the growing importance of naval shipbuilding in comparison with mechanical activities. Finally, a similar trend is also detectable in profits (figure 4.7). The 1880s were a period of growing profits. Profitability, however, collapsed in the early 1890s. The rebound of activities in the second half of the 1890s increased again profits which in 1897 were more than 3.5 million Lire. Profits' variability over time was still, however, large, with massive swings year after year.

Figure 4.7: Ansaldo's reported profits, 1884-1900 (in current Lire).



Source: AFA, FP, Ssm bis, b. 2, f. 3.

From the mid 1880s, Ansaldo's management was pursuing a strategy of vertical integration.[69] Moving from naval engine making into naval shipbuilding was a first step: Ansaldo could exploit its know-how and connections with the Navy to enter a sector in which there was a smaller number of competitors. During the 1890s, Ansaldo increased the number of productions it could perform "in house", showing a preference for organic growth rather than acquisition: in 1894 it bought Delta, a

69 On vertical integration as a business strategy, M. K. Perry, 'Vertical Integration: Determinants and Effects', R. Schmalensee and R. D. Willing, *Handbook of Industrial Organization*, vol. 1 (Amsterdam, 1989), 185-255.

metallurgical supplier based in Sampierdarena which had become bankrupt; in 1896 it started the erection in Campi (in the northern outskirts of Sampierdarena) of a plant to cast the steel pieces it required, and in 1897 opened an electromechanics unit for the manufacture of electric components. At the turn of the century two key components were still missing, however, before Ansaldo could become a fully integrated armaments company: artillery and armour. Both productions, to be successfully undertaken, required large capital investments and could be operated efficiently and economically only if large economies of scales were achieved, posing a financial problem for any firm willing to venture into these sectors. At the same time, gun manufacturing and armour plate production presented many more technical difficulties than shipbuilding or engine making. What is more, such venture could be successful only if it could rely on a sustained demand. By 1900, the claim that Ansaldo could "make an entire vessel of the most powerful and large kind" was still an aspiration rather than a reality.[70]

While Ansaldo had adopted a strategy of organic growth, Orlando pursued a different direction. Orlando had been active in warship building for much longer than Ansaldo. For instance, Orlando built *Lepanto*, the first capital vessel built by a private yard. Orlando subsequently moved from shipbuilding, its core activity, to naval engineering. The first significant order received from the Navy in this field were two 7,000 HP engines for the torpedo rams *Etna* and *Vesuvio* in the early 1880s, machines which, as in the cases of some of Ansaldo, were based on the designs provided by a British firm, in this case Hawthorn & Co.[71] Naval engines, however, was a niche where Ansaldo maintained its leadership. In addition, Orlando as well as Odero, built many more merchant vessels than Ansaldo, and they were therefore able to better weather the fall in naval budget.

Under the management of Giuseppe Orlando who succeeded his father Luigi at the helm of the firm, the company started to develop links with other yards (especially with the ones owned in Genoa by Attilio Odero) as well as, more crucially, with Terni. Terni was Orlando's key supplier of steel forgings for naval construction and it enjoyed a virtual monopoly in the production of special steels for military uses, making armour plates and the steel used by Armstrong to make guns in Pozzuoli. The aim of Giuseppe Orlando was to integrate Terni's steel operations with shipbuilding in order to lower costs, secure supply and gain a dominant in the market for warships. Giuseppe Orlando joined the board of Terni for the first time in 1895, but it took ten more years for him and

70 *Officine e Cantieri Gio. Ansaldo & C.*, (Genova, 1900), 6.
71 *Commissione Industire Meccaniche*, 17.

Odero to acquire full control of the firm (this topic is dealt with in chapter VII).[72]

While the Italian Navy still bought abroad a few, but technically advanced, pieces of hardware, the Italian naval industry was itself able at the turn of the century to become an exporter of warships. The growing interest for foreign markets of Ansaldo was signalled in the second half of the 1890s by the development of a network of agents abroad, mimicking the strategy that Armstrong and Vickers had implemented in the 1870s and 1880s. The Italian naval budget had declined from the peak of the late 1880s, and exporting abroad could offer a way to turn into profits the investments which had been made. Odero and Orlando probably equally employed foreign agents, although the records do not reveal much about this. In general it seems that Ansaldo was more active in the search for foreign customers, probably because of its higher exposure to defence spending.

Even though Orlando was able to sell a pair of gunboats to Portugal and Morocco, the real coup for the Italian armaments industry was the sale of seven *Garibaldi*-class cruisers. In the early 1890s, the Italian Navy ordered two cruisers, one from Ansaldo and one from Orlando. These vessels offered a good combination of speed and armaments with a relatively compact displacement (7,300 tons each ship, in average).[73] They were able to operate either in combination with other vessels or alone. The project had been a joint venture between Edoardo Masdea,[74] the chief Navy architect, and Ansaldo's designers.

The first ship of the class, the *Garibaldi*, was laid down in 1893 and was the largest vessel ever built by Ansaldo up to that time. Two years later the Italian Navy agreed to sell it and the sister ship which Orlando had laid down, to Argentina. Ansaldo and Orlando committed themselves to replace these ships with two new ones for the Italian Navy. At the end, the Italian Navy received its own *Garibaldi* cruisers seven years later: in fact, five additional cruisers were built (four by Ansaldo and one by Orlando) and exported. Between 1895 and 1902 Argentina bought four ships, Japan two and Spain one. In 1896 Brin could proudly say in parliament that "this sale was one of the most beautiful events of our industry". There is no doubt that he saw his policy of supporting Italian firms vindicated.[75]

Propitious international circumstances facilitated the sales in South America: since the late

72 AST, Fondo Terni, b. 33, *Verbali del Consiglio di Amministrazone*, 16 June 1895.
73 E. Bagnasco and A. Rastelli, 'Le Costruzioni Navali Italiane per l'Estero', supplement to *Rivista Marittima*, December 1991, 35.
74 M. Gemignani, 'Masdea, Enrico', *DBI*.
75 The debate on the sales of the *Garibaldi* cruisers is in Camera dei Deputati *Atti Parlamentari, Discussioni*, XIX Legislatura, vol. 5, (Roma, 1896), 5229-5246.

1880s Chile and Argentina had been competing for the possession of Patagonia and its deposits of coal and guano.[76] Both countries strengthened their navies by buying vessels abroad. Elswick itself sold two cruisers, one to Argentina and the other to Chile.[77] Both countries lacked the ability to built their own ships, thus they had to rely on purchases abroad, and they also needed to acquire vessels fast, so to outpace the rival. The two Italian *Garibaldi* cruisers already laid down could therefore provide Argentina with a decisive advantage. Contacts between Argentina and Ansaldo were the results of the efforts of Ferdinando Maria Perrone, the firm's agent there. Perrone had a decisive role in convincing the Argentine government to buy the Italian ships, instead of relying on the more experienced British yards.[78] When in 1902 Chile and Argentina, fearing the escalating costs of the naval build-up, reached a temporary agreement, the Argentine government sold the two additional vessels it had bought from Ansaldo to Japan, which was now enlarging its fleet as fast as possible to be ready to confront the Russian Navy.

There is no doubt that international tensions created the momentum for the sales of *Garibaldi* cruisers, which were in turn facilitated by Perrone's contacts and commercial skills and the rapid availability of the vessels. It would be wrong, however, to disregard the fact that middle-size, fast cruisers represented exactly the market niches in which, at the turn of the century, Italian armaments firms could compete more effectively. In each *Garibaldi*, hull, engines and boilers represented around 60% of the total displacement, with armour plates 25%, and guns 15%. The fact that armour plates represented a relatively smaller part of the total displacement that in larger capital ships meant that Ansaldo and Orlando could successfully compete with foreign firms in assembling the hull and installing triple expansion engines, both processes in which Italian mechanical firms had accumulated experience and know-how. Ansaldo was building naval engines since the early 1860s, and was involved in naval shipbuilding since 1886. At the same time, the size of the vessels did not force the yards to do the investments and improvements which could have been required by the construction of larger vessels.

In addition, Ansaldo's yard (and to a less extent Orlando as well) was able to drive down costs and reduce construction times because it built a series of similar vessels, one immediately after the other. While Ansaldo took three years to complete a small 850 tons light cruiser in the

76 S. Collier and W. F. Sater, *A History of Chile, 1808-1994* (Cambridge, 1996), 186-87.
77 R. Scheina, *Latin America: A Naval History 1810-1987* (Annapolis, 1987), 46-7.
78 The letters exchanged between Perrone and Ansaldo's management detailing the negotiations are in AFA, FP, SSN 30; see also P. Rugafiori, 'Ferdinando Maria Perrone. Un italiano in Argentina tra Politica, Cultura e Affari (1885-1900)', *Studi Storici* 31 (1990), 709-712. To facilitate the sale, Perrone paid bribes to higher ranking politicians and naval officers (among them the President of the Republic, Julio Roca). The fact that in his letter he called the bribes "English oil" points to the fact that, when dealing with South American Republics, this was a common practice.

1880s, each *Garibaldi* (much bigger ships) were finished in less than three years.[79] Finally, the fact that all armaments for these ships came from Pozzuoli, could have made Elswick less pugnacious about competing with Italian firms in a market, Argentina, in which it had maintained a dominant position until then because it was still making a profit out of sales. This was especially convenient at a time when Armstrong was selling Chile the ships it wanted to counteract the Argentina's new *Garibaldi*. Using Italian firms as proxies, Armstrong was then able to sell naval armaments to both countries.

4.4. *Protectionism and the Italian armaments industry.*

The rise of the Italian armaments industry has usually been linked with the protectionism policies adopted in the 1880s. Steel production was regarded as the necessary precondition for industrialisation. Metallurgical production could develop only behind tariff barriers.[80] In 1887 the Italian parliament approved a new law which introduced, or increased, tariffs on several agricultural and industrial goods. The repercussions that protectionism had on the Italian economic history have been strongly debated, with some scholars offering a positive assessment, while others being more critical.[81] It seems important, therefore, to offer a brief analysis of the impact that protectionism had on the Italian armaments sector.

Terni was certainly a *cause celebre* against which many Italian free-traders economists, such as Einaudi and de Viti de Marco, and politicians spoke and wrote. The fact that the government had introduced in the 1887 tariffs for the protection of the steel and iron industry was regarded a huge

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79 Perrone boasted that for Ansaldo it was possible to deliver 3 *Garibaldi* in sixteen months, see AFA, FP, SSMbis, b. 68, f. 9.

80 F. Amatori, 'Italy: the Tormented Rise of Organisational Capabilities Between Government and Families', A. Chandler, F. Amatori and T. Hikino (eds.), *Big Business and the Wealth of Nations* (Cambridge, 1997), 255.

81 There are scholars who offer a positive assessment of the tariffs, underlying their positive role in fostering industrialisation, even though recognising the *ad hoc* nature of many commercial decisions; see, for instance, V. Zamagni, *Economic History*, 116-17, and G. Sapelli, 'Technical Change, Microeconomic Evolution and Growth: an Introductory View of Italian Industrial Development', G. Dosi, R. Giannetti, e P. A. Toninelli, (eds.), *Technology and Enterpriese in a Historical Perspective* (Oxford, 1992), 291-313. By contrast, there are scholars who are highly critical of Italian protectionism which, for to them, was detrimental to the economic development of the country; among them A. Gershenckron, *Economic Backwardness in Historical Perspective. A Book if Essays* (Cambridge, 1962), 80-83, and S. Fenoaltea, 'Politica Doganale, Sviluppo Industriale, Emigrazione: verso una Considerazione del Dazio sul Grano', *Rivista di Storia Economica* 10 (1993), 65-77. Finally, there are scholars who simply downplay the significance of protectionism for the economic development of Italy, see G. Federico and R. Giannetti, 'Le Politiche Industriali', *Imprenditorie e Imprese*, vol. 22 of *Storia d'Italia* (Torino, 1999), 1130-33. For an analysis of the political economy behind the introduction of tariffs, V. Castronovo, *Da Contadini a Operai*, vol. 7 of *Storia d'Italia* (Torino, 1975), 96-99.

mistake which harmed the Italian economy by blocking the development of other sectors, especially the engineering industry, which was the major user of steel and iron. Terni, because of its size, and the many favours it had received from the Navy, was naturally highlighted as the symbol of government intervention in the economy. Terni's establishment had some positive effects, however: before it was created, the Italian steel industry was, in quantitative terms, small. When Terni started to produce, national output of steel immediately more than doubled.[82] In addition, Terni was the first to introduce in Italy the most advanced techniques, such as open hearth furnaces.

More generally, the introduction of trade tariffs and commercial barriers did not seem to have played an important role or to have influenced in any significant way the strategies or the development of Italian private armaments firms. This is for two reasons. First, since the early 1880s, Italian armaments companies received a growing share of the procurement contracts awarded by the Italian Navy. This increase, however, was the result of a specific strategy, rather than because Italian firms had become more competitive than foreign producers. In other words, the decision to favour Italian private firms was the product of a change of mind among the military and political élite of the country, rather than the outcome of the transformed economic circumstances driven by protectionism.

Secondly, Italian protectionist policy was designed in a way which did not naturally favour armaments companies. Engineering goods received very light protection. In 1877, 1889, 1897 and 1913 the ratios of effective protection of machinery to the average general rate of protection were respectively 0.1, 0.3, 0.3 and 0.5.[83] Iron and steel, in contrary, received a higher degree of protection: their ratios of effective protection in the same years were 1.6, 2.0, 2.8 and 3.2.[84] This meant that Italian armaments firms were forced to purchase steel inputs at a higher price than it would have been possible otherwise because of the protection enjoyed by steel. These extra costs, however, were added to the final price paid by the Italian government and thus did not represent an impediment. The only company which obtained a clear advantage – one, however, whose magnitude is extremely difficult to assess – was Terni, whose civil production was favoured by the

82 Istat, *Sommario di Statistiche Storiche* (Roma, 1976), 95. While this was a significant increase, the Italian steel industry was still extremely small in comparison with the foreign competitors: in 1890 Italian steel production accounted for near 1% of the entire world production, while Britain, Germany, the USA, and France accounted respectively for 29%, 16,5%, 34,5% and 5,5%. See Ilva, *Altiforni e Scciaieri d'Italia. 1897-1947* (Bergamo, 1948), 320-21.

83 See G. Federico and A. Tena, 'Was Italy a protectionist country?', *European Review of Economic History* 2 (1998), 86.

84 Steel, however, was not as protected as several agricultural goods, whose producers were able to lobby the government to obtain a much higher level of protection. For instance, the ratio of effective protection on sugar was on average higher than 15 for the period 1877-1914, peaking at 24.4 in 1897!

protection. It is difficult to conjecture, however, the impact that these extra profits had on the armaments side of the business

It is possible to claim, however, that more expensive iron and steel-made inputs had an impact on the competitiveness of Italian armaments abroad. Theoretically exports could have been damaged by the higher costs induced by protection. There are, however, good reasons to discount such a view. It is true, as it will be said in the next chapter, that Armstrong lamented that the high cost of Terni's steel limited Pozzuoli's ability to export abroad. At the same time, however, the most successful export coup by the Italian armaments industry – the sales of several *Garibaldi*-class cruisers – happened at the end of the 1890s, that is in a period in which protection policies were already in force. What is more, the crucial steel item required by armaments companies was armour plates. However, armour plates during the 1880s and 1890s evolved to become a much more sophisticated product, involving the use of special alloys and complex technical practises, thus the impact that protectionism could have on such a technically advance production was limited, because the plates' price was mainly driven up by the complexity of their manufacturing process.

The only way in which tariffs helped the Italian armaments industry was probably through the fiscal channel. Tariffs raised revenues which could be spent by governments to buy new vessels and guns. It is impossible, however, to offer any precise analysis of this aspect.

4.5 *Conclusion.*

Three key features characterised the period covered in this chapter. First, the irregular trend of Italian naval spending. The naval budget grew during the 1880s, but stagnated for the majority of the 1890s. This fact had an impact on the performance and the strategies adopted by armaments companies. Naval shipbuilding especially suffered. The ups and downs of the Italian naval budget explain why, whereas in Britain Armstrong and Vickers were able to collaborate and to achieve a certain degree of cooperation, as it will be better explained in chapter VI, this did not happen in Italy. The competition between Ansaldo and Orlando-Odero was always strong.[85] The uncertainty

85 See for example the letters exchanged between the Bombrini and the naval administration, and between the Bombrini and their agent in Rome, Francesco Ruffo, price of Palazzolo, AFA, AP, Serie Copialettere, n. 1-3. They pointed to freemasonry links between Orlando and the Minister of the Navy Morin to explain why Ansaldo did not received more orders from the government. See also the correspondence with Perrone, equally peppered by strong judgement against the “Leghorn clique”, “the Southern party supporting Naples industries”, etc., see AFA, FP, SSM ter, b. 97, f. 7. Unfortunately, the disappearance of Orlando's records deprive us of the possibility of reading their accusations against Ansaldo.

about the future level of expenditure meant that it was impossible for firms to arrive at an understanding because there was the danger of dividing too small an amount of orders. The need to constantly invest in order to modernise yards and engineering plants only exacerbated the problem of how to saturate the available capacity. Ansaldo and Orlando tried to increase their sales and their market shares rather than trying to maximize profits. This problem was made more serious by the fact that during this period the Italian Navy, especially in moments of financial constrains, always privileged its own arsenals and yards to the detriment of private firms.

Second, during this period, production undertaken in Italy substituted imports to a large degree. The Italian armaments sector as a whole increased its range of production, adding large calibre guns (Pozzuoli) and armour plates (Terni). In both cases the role of the Navy was decisive in providing financial support and long-term orders. Because of its importance, and of the size of the support it received from the government, Terni attracted much controversy. Whatever the economic cost for the collectivity of its establishment, the creation of Terni achieved the aim for which the Italian Navy had supported it. Terni, in fact, rapidly supplanted foreign steel makers as the key supplier of armour plates and gun forgings. Despite its limitations in terms of innovations and its higher costs, Terni's production was of comparable quality with that of foreign steel mills. In this respect, thus, the establishment of Terni can be regarded as a success, if not for the general welfare of the country, certainly for the strategic position of the Italian Navy.[86] The substitution of imports with domestic production was not totally acheived, however. The Italian government did not stop buying from foreign firms, but the order of magnitude of these purchases was much smaller than the ones occurring in the period 1860-1880. The Navy still acquired specific technological know-how or hardware from foreign suppliers when this was regarded as of superior quality. Also in these cases, however, Italian firms moved swiftly to replicate foreign designs.

Third, the Italian armaments industry underwent a process of growing sophistication which was highlighted by the sales of various *Garibaldi* cruisers to Argentina, Spain and Japan, markets which until then had been dominated by British firms. Selling seven middle-sized vessels abroad was no mean feat and this immediately put Italy among the most important defence suppliers in the world. The commercial success of the *Garibaldi* testified to the many gains that Italian armaments firms had made in terms of cost savings, rapidity of construction, design. The experience

86 The creation of the Terni steel plant had a decisive impact on the local community as well: between 1882 and 1901 the annual rate of demographic growth of Terni's municipality was 48.82‰, the second highest in Italy, after Spezia, R. Covino and G. Gallo, “Le Contraddizioni di un Modello”, id. (eds.) *Storia d'Italia dall'Unità ad Oggi. L'Umbria* (Torino, 1989), 83-84.

accumulated in two decades of shipbuilding for the Italian Navy was now starting to ripe profits. Italian firms could be competitive in the international armaments markets, and especially so in certain niches. Their major weakness was that they were still unable to autonomously develop major technical innovations, and they had to rely on foreign companies the access to the most up-to-date know-how either as semi-finished goods or as designs and plans.

In general, the major difference between the Italian and British experience during the 1880s and 1890s was the role played by the state. In both countries naval administrations and private firms developed links and strong relationships ("revolving doors" between the high ranks of the military and bureaucracy and the armament companies firms were common in Italy as well as in Britain), but only in Italy these connections played a decisive role in the creation of an armaments industry.

Chapter V

The Creation of an Armaments Plant in Italy: Pozzuoli, 1884-1900

This chapter analyses the creation and the first fifteen years of activity of the gun-making plant of Pozzuoli which Armstrong established in 1884. In the early 1900s Armstrong reformulated its strategy about the Italian market. This second period will be addressed in chapter VII.

Pozzuoli represents an interesting case study for three reasons. First, it was the most important foreign direct investment ever made by Armstrong in its history, and probably the major venture abroad by any armaments company before 1914. It is thus essential to understand the reasons behind Armstrong's move and to place it in the context of the firm's growth strategy of the 1880s. Second, Pozzuoli was the only plant in Italy able to manufacture large and middle sized naval guns until the early 1910s. This made it pivotal in the subsequent evolution of the armaments industry in Italy. Finally the records about Pozzuoli, despite being incomplete, cast some light on the early stages of the erection of a new gun making plant making this case study highly interesting.

The chapter is organised as follow: the first section investigates the reasons why Armstrong decided to create a branch in Italy; the second discusses the investments carried out in Pozzuoli for erecting the gun making shop; the third deals with the evolution of Pozzuoli in the second half of the 1890s.

5.1 *The Origins of Armstrong's Italian venture.*

As it has been said in chapter I, the Italian government was among the first customers of Armstrong, and remained a loyal purchaser for more than two decades. Italy needed the guns Armstrong made because there were no Italian firm (or arsenal) able to make the naval ordnance and gun mountings required to arm the country's fleet. However, such a situation, which replicated the one existing for armour plates, was not fully satisfactory for the Italian Navy which faced a trade-off between security of supply, which would be enhanced by the presence of a domestic producer, and quality, which Armstrong guaranteed.

The first time Armstrong's management considered the possibility of expanding the firm's

operation to Italy was in 1868. In the first half of the decade, Italy had been a good purchaser of Elswick's ordnance for its new fleet of ironclads, therefore Stuart Rendel suggested that the company might consider opening a plant somewhere in Italy. The records do not allow us to know whether Rendel had been informally approached by Italian representatives, or if this had been his own idea. On the surface, the prospects of such a venture looked favourable: after the dramatic defeat at Lissa two years before, the Italian Navy needed to be rebuilt, and thus it was rational to expect significant orders for guns. Moreover, the evolution of artillery technology was rapidly making obsolete the first rifled ordnance, stimulating additional demand for newer guns.

However Armstrong rejected the idea of building a plant in Italy. He stressed that "we have had experience in our own country of what may be deemed a sort of government concession with regards to guns, and we are quite sure that the evils we encountered in that case would be ten times worse in any foreign country." Moreover, he added, there were other problems which needed to be taken into account: "there is the instability of most foreign governments – their pecuniary embarrassments and their jealousy of foreigners."[1] Clearly, Armstrong's previous dealings with the British government had made him sceptical of the idea of working too closely with a government. It was one thing to sell guns to customers around the globe, with the company's management in firm control of the business; it was another to set up a plant in a foreign country, with the concrete risk that the host country's government could meddle in the running of the operations.

Moreover, Armstrong refers between the lines of his message to two additional reasons militating against such a proposal. The first was that Italy's budget was in a precarious state (the "pecuniary embarrassment"): it was possible that Italian governments – which had the habit of changing very fast[2] – could find themselves short of money and therefore unwilling to buy or unable to pay for guns. In fact the Italian naval budget was drastically cut in the second half of the 1860s to help rebalancing government finance. Second, Armstrong feared that, in case the hosting country's government was not able to award the expected amount of orders, a foreign-owned branch could have difficulties in acquiring contracts from other governments or from private customers exactly because of its foreign nature.

The combination of all these reasons weakened the bargaining power which Italy could exercise with Armstrong. The Italian government, simply speaking, was in no position to force the firm to create a plant in Italy: the carrot of future orders was unconvincing because of the perilous state of the budget, the stick – the menace of not buying any longer from the firm – was

1 T&W, 130/5375, 28 August 1868.
2 Between 1861 and 1869, twelve governments alternated in office.

implausible, because the technical leadership enjoyed by Armstrong in naval artillery manufacturing made it difficult for Italy to renounce to its products. Such a strong rejection of the suitability of a multinational organisation was significant and had a lasting effect on the firm: for the next two decades it refused to open any foreign branch and continued to operate through its well-established scheme of agents spread around the world, while, in contrast, production was centralised in Elswick, under the direct supervision of the head office. Despite rejecting the idea of establishing a branch in Italy, Armstrong and Italy developed a still closer relationship in the subsequent years. During the 1870s the naval race which involved Italy against France favoured the sales of guns: during that decade Armstrong sold guns worth more than 6,000,000 Lire to Italy. Another sign of the links which existed was that George Rendel was asked to join a design committee of the Italian Ministry of the Navy to advise on technical matters.[3]

Hence, when in 1883 the company received an offer to buy the works of Mr Guppy & Co in Naples, the board seriously discussed this opportunity. Guppy & Co. was established in Naples in 1853 by Thomas Guppy, a Bristol born engineer who had moved there in the 1840s to work for a fledging Neapolitan railways company.[4] Later, he established an engineering firm which produced railways material, naval engines and other mechanical products.[5] In 1882 he died, and in the months following his demise, Guppy's heirs looked for a way to monetize their inheritance. Inside Armstrong's board, it was especially Andrew Noble who was in favour in the light of the "desirability of the company possessing works of some sort in Italy with the view of retaining the government connection".[6] In the end, however, the proposal was rejected due the fact that "the works being ill adapted for our purpose and not favourably situated".[7] Guppy's plant, in fact, was not near the sea (a fact which facilitated logistics, especially in case of heavy and large products), but several miles inland.

The following year it was the Italian Navy itself which began to press Armstrong's to start producing guns somewhere in Italy The initial contacts with Armstrong were "verbal, with no documentation left".[8] This move fitted in Brin's strategy of fostering the creation of Italian-based armaments plants to free the country from the need to import the key military components needed in warship construction. Trying to convince Armstrong, the Navy's exclusive supplier of large naval

3 M. R. Lane, 'Rendel, George', *ODNB*.
4 See Guppy's obituary in *The Times* 6 July 1882, 6.
5 L. de Rosa, *Iniziativa e Capitale Straniero nell'Industria Metalmeccanica del Mezzogiorno 1840-1904* (Napoli, 1968), 51-62.
6 T&W 130/1264, *Minutes of the Board*, 18 July 1883.
7 Id., 12 and 13 September 1883.
8 *Inchiesta sulla Marina Militare*, *Relazioni Speciali*, 155.

ordnance, was thus a crucial step, as decisive as the creation in Italy of a plant for the manufacture of armour plates. In April, a month after Brin had been nominated Minister for the second time, Armstrong's minutes record that the board replied to a letter from the Italian Ministry of the Navy stating that it was ready to give its best consideration to the matter of opening a branch in the country.[9] In July, the board decided that a "letter be written to the Minister of the Navy announcing that the Board accepts the principle of his proposal, and is prepared to enter upon a provisional agreement in the sense of his communication, and that the Board will despatch forthwith a confidential agent to Italy to report upon the most favourable site."[10] While the board replied to the Minister, it also wrote privately to Albini – who, at that time, still was the General Director for Ordnance and Torpedoes in the Ministry – to ask for his opinion. We can speculate that Albini underlined how serious were Brin's intentions and strongly suggested accepting his "invitation".

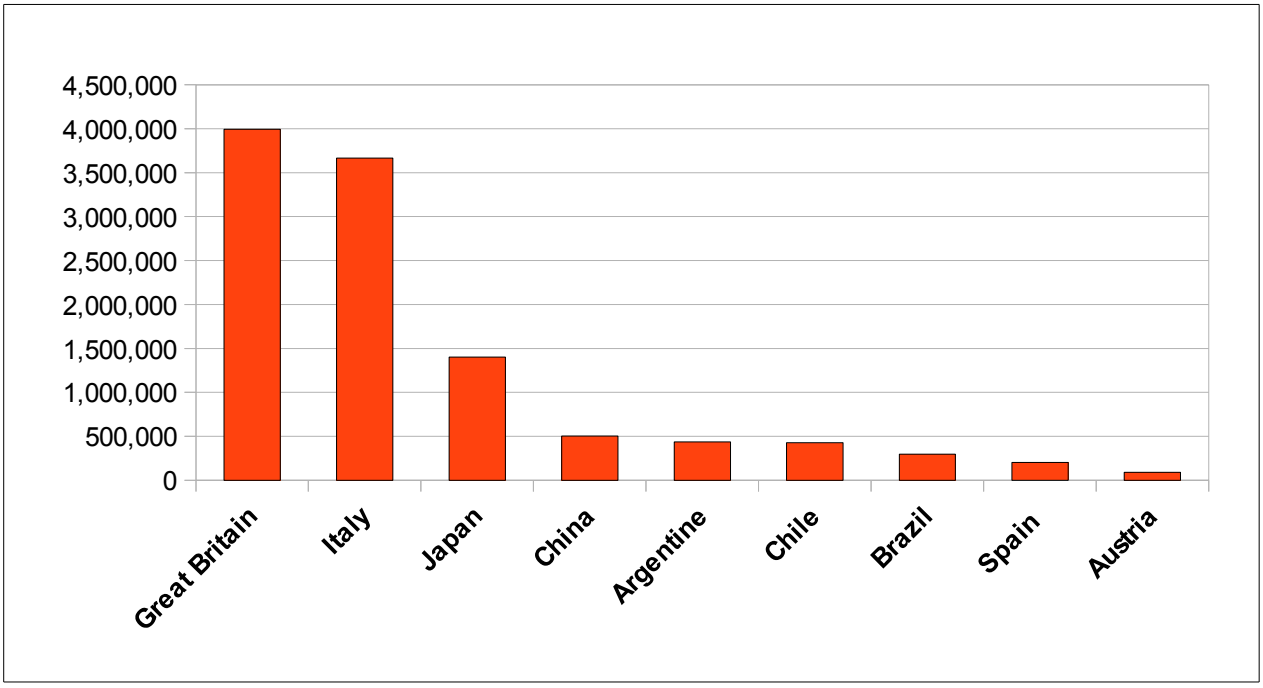
Why did Armstrong accept now to create a plant in Italy? Why did it venture into making a large direct investment in a foreign market, after having shunned all previous opportunities to do so? The reason was that in 1884 the leverage power enjoyed by the Italian government on Armstrong was much stronger than it had been two decades before. In the 1860s and 1870s Italy did not have the means to drive a hard bargain with Armstrong. This time, in contrary, the company faced a more serious dilemma. Brin threatened to stop buying from Elswick if the company did not create a plant in Italy. He told the Chamber of Deputy that: "I wrote to the company [i.e. Armstrong] making known that I did not want to deal with it about ordnance supply any longer, if it did not engage itself to manufacture ordnance in our country."[11]

Figures 5.1 and 5.2 show how serious the threat was for Armstrong. They report the instalments received on account of works in progress for the years 1884-1895 (figure 5.1 presents the total amount paid during the entire period by the major customers, figure 5.2 reports data year by year). After a government signed a contract, it paid a first instalment, then one or more additional instalments were paid while the firms carried on production, and a final instalment was paid at the completion of the contract. The payment of instalments during production helped the firm to self-finance its operation and to preserve a healthy amount of working capital. Thus, in absence of better data, the accounts for works in progress can be used to assess the amount of works Armstrong received from different customers and, consequently, the relative importance of various clients for it.

9 T&W 130/1264, *Minutes*, 24 April 1884.
10 Id., 3 July, 1884.
11 *Atti Parlamentari della Camera, Discussioni*, 6 February 1885, vol. 10, 11483.

The data shows clearly how important was Italy: from 1884 to 1895, Armstrong received a total of £3,993,030 from the British Admiralty and War Office. Italy represented the second most important customer, paying advances each single year during this period for a total sum of £3,666,537 (counting advances for works made both in Elswick and, later, in Pozzuoli) but, in the years 1884-1886 Italy paid Armstrong more than any other country. Japan was the third most important customer, followed by China and the three major South American naval powers: Argentina, Brazil and Chile. Brin could use the Italian large purchases as a bargaining tool with Armstrong: Elswick had received large orders from Italy, thanks to the increasing naval budget, whose continuous growth promised further big orders. To retain such a major customer, Armstrong had no other option but to accept the "suggestion" to build a plant in Italy, hoping, in the process, to extract the best possible conditions for the investment. The threat made by the Italian government was not to be taken lightly.

Figure 5.1: Instalments received on account of works in progress, 1884-95 (in current pounds).



Source: T&W Archive, 130/1330-1341.

Figure 5.2: instalments received on account of works in progress by year, 1884-95 (in current pound).

Year	Italy	Admiralty	War Off.	Japan	Argentine	Brazil	Spain	China	Austria	Chile	Pozzuoli	Total
1884	230,785	27,300	28,809	101,500	6,428	39,568						**434,390**
1885	210,216	48,030	53,490	307,883	12,856	44,494						**676,969**
1886	376,909	202,650	57,520				40,946	185,055				**863,969**
1887	293,384	403,640	149,960				85,660	317,355	12,600			**1,262,599**
1888	403,302	463,700	189,120				17,056		36,085	12,944		**1,122,207**
1889	521,268	308,318	281,060				16,986		42,950	2,434		**1,173,016**
1890	300,428	356,883	198,263	42,032	196,041		42,023			1,861		**1,137,530**
1891	123,624	167,150	193,719	30,669	19,440	37,239					163,792	**735,633**
1892	106,086	199,944	26,513	157,250	64,910	123,135					240,068	**917,906**
1893	8,813	267,695	31,114	283,920		36,085				99,165	185,910	**912,702**
1894		102,433		148,412		17,426				264,440	256,619	**789,330**
1895		209,717	26,003	330,965	136,875					45,419	245,333	**994,312**
Total	**2,574,815**	**2,757,459**	**1,235,571**	**1,402,631**	**436,550**	**297,947**	**202,671**	**502,410**	**91,635**	**426,263**	**1,091,722**	**11,020,563**

Source: figure 5.1

The contract between Armstrong and the Italian Ministry was signed on 12 January 1885. The Italian government did not commit itself to any payment to Armstrong for the establishment of a gun plant in the country; by contrast, "the total cost of the plant must be met by the Armstrong Company."[12] The government's only obligation was to order guns worth £670,482 to be delivered in the next six years. As an incentive, the Navy agreed to pay 10% more for guns made in Italy than if they had been ordered in Britain. Considering that the Italian government paid the shipping costs from there to Italy, the 10% premium represented a lower increase in the final cost for the Italian government than the simple number would suggest. Additionally (article 13 of the contract) the Navy agreed to pay an addition premium equal to the 10% of the price of a gun, if the firm used Italian-made steel. This provision was clearly added with the aim of supporting Terni, the only firm in Italy which manufactured steel gun forgings.

It is worth reporting extracts from the text of a memorandum dated February 1885 circulated inside the Italian Ministry of Marine about the contract, a document signed by Admiral Brin and by admiral Albini. The report highlighted the strategic, economic and technical reasons behind the Navy's efforts to secure the establishment of Armstrong in Italy.

> Every state, whose military forces have achieved a certain status, needs to free itself from dependence upon foreign military production, and it tries […] to manufacture arms and ammunitions on its own territory. But, if in the past it was relatively easy, ever for the small Sardinian, Tuscan and Neapolitan States, to set up ordnance works, now the problems have been greatly increased, because the war materials are now masterpieces, produced by the most expensive and modern industries, and it is impossible, without huge expenses and heavy risks of failure, to try again what Russia has done: the creation of a plant for the manufacture of steel guns.
>
> We have seen famous firms be unsuccessful in building guns, and, although many companies manufacture excellent machines and devices, only two in the world have been able to achieve fame as good and reliable gun-makers: the Essen [i.e. Krupp] and Elswick shops.
>
> Every government which wants strong and effective guns is forced to turn to one of these two works. […] it is convenient that the Italian government should

12 Article 18 of the contract, whose text is in *Inchiesta sulla Marina Militare*, vol. 2, 155-156.

turn to Elswick to transplant in Italy the manufacture of steel ordnance.

> There can be not doubt about the choice. The constant, unanimous votes of the Supreme Council of Marine and of every technical commission of the Navy and the recent decision of the Ministry of War in favour of the Armstrong guns suggested it [note: the Italian Ministry of War, in a rare order for private armaments firms, had purchase a few Armstrong guns for the inland defence of Spezia arsenal]. Armstrong company manufactures naval ordnance as effective and as reliable as Krupp's ones, but at half price.
>
> Two ways could be used to obtain the transplantation in Italy of shops like Elswick: to set up works paid by the Government, as in Russia, or by the Armstrong company at its own risk and expenditure, the Government committing itself only to buy a certain amount of production from the new Italian Works.
>
> The first system would expose us to huge expenses and risks. […] for us, who were going to order a considerable amount of hardware from Armstrong, the second way was the cheapest and more appropriate.[13]

According to the Enquiry Committee on the Navy which surveyed the evidence twenty years later, in reality there was no unanimity inside the Supreme Council of the Navy. Admiral Saint-Bon, the predecessor of Brin and his former mentor, was a critic of the agreement. He was so on two grounds: first, the Ministry – despite this fact being not explicitly stated in the contract – was morally binding itself to support the firm in the future, thus limiting the freedom to order artillery from other producers; second, the agreement locked the Navy into making use of specific designs and projects while it was still unclear what would be its future artillery requirements.[14] In addition, there was also a political undertone in the disagreement: Saint-Bon, who belonged to the traditional free-trade "historical right", while favouring the strengthening of the Italian Navy, did not share Brin's strategy of directly supporting private companies.[15] The critics were overcome, however: Brin stressed, among the advantages of the deal signed with Armstrong, that the Navy could more easily monitor the manufacture of guns if it was undertaken in Italy, and that his should reduce the delays in delivery.

The following year Albini, who had being in favour of the agreement with Armstrong, quit

13 ACS, Fondo Marina Militare, Direzione Generale d'Artiglieria ed Armamenti, b. 580, f. 1197, 20 February 1885.
14 *Inchiesta*, *Relazioni Speciali*, 156.
15 M. Gabriele, *Benedetto Brin* (Roma, 1998), 25.

the Ministry to become a director of Armstrong.[16] This was the fulfilment of an arrangement reached in 1885 between Albini and Elswick: the company's board had decided that "on the termination of his appointment under the Italian government, he [i.e. Albini] should become a director of this Company with special reference to the Italian affairs".[17] This fact casts some suspicions on the indepndence of Albini but it was hardly unique among naval officers.

The contract signed with Armstrong generated anxiety among Italian engineering firms. For example, the Chamber of Commerce of Genoa, one of the most influential, and to which, for instance, both Ansaldo and Odero belonged, wrote to the Ministry of the Navy to receive assurances: Italian firms were worried about facing a strong foreign competitor in their domestic market. They feared that Armstrong could expand its production outside ordnance manufacturing to shipbuilding and civil engineering, all activities which Armstrong carried on at Elswick. Brin replied that the contract signed with Armstrong was only about setting up an ordnance plant to "build in the country hardware that we have always bought abroad". Moreover, the Minister added that "it has never been a government intention to grant any privilege to this establishment".[18]

The combination of promises of future orders and threats to stop buying from it had convinced Armstrong to venture in Italy, reversing its policy of not opening branches abroad. Italy was a crucial customer for Elswick, and Armstrong did not want to risk losing it. Italy's naval budget had been growing since the late 1870s, therefore the venture promised to be profitable. In combination with the erection of Terni, Armstrong's Italian artillery works strengthened the strategic position of Italy and reduced its dependence on foreign military suppliers. As in the case of Terni, the contract with Armstrong was not unopposed, but the economic and strategic climate allowed both ventures to be approved.

5.2 *The creation of Pozzuoli.*

During the second half of 1884, Armstrong's management was busy planning the firm's new venture. In November, Andrew Noble travelled to Italy to personally hammer out a compromise with the government. He visited Italy again in January.[19] The first decision Armstrong's

16 P. Ferrari, *Verso la Guerra. L'Italia nella Corsa agli Armamenti 1884-1918* (Vicenza, 2003),156.
17 T&W 130/1264, *Minutes*, 4 March 1885.
18 ACS, Fondo Marina Militare, Direzione Generale d'Artiglieria ed Armamenti, b. 580, f. 1946, 23 February 1885.
19 T&W 130/1264, *Minutes*, 29 January 1885

management had to take was whether to enter into the Italian market by a “greenfield investment” (that is by establishing a plant *ex novo*), or through acquiring a local firm. As it has been reported above, Armstrong had had the opportunity to acquire established firms in Italy, but it declined all the offers. Buying an existing firm would have speeded up the entrance into the new market because it would have brought Armstrong a workforce, established links with suppliers, and saved it the time of erecting a new plant. In the end, however, Armstrong decided to create its own plant, as happened in the majority of the foreign direct investments undertaken before 1914.[20] The chief reason was that there were no suitable targets in Italy. Obviously, no gun making firm existed which could be bought and enlarged. There were many engineering firms, but few of them were large, or modern enough, to justify an acquisition. What is more, it is likely that Armstrong's management wanted to be in full control of all the organisational arrangements of the new plant and thus favoured the idea of a “greenfield” investment.

Having decided to create a plant somewhere in Italy, the next decision was where to establish it. The Ministry did not influence such a decision, which was left to Armstrong's managers. The board first considered Spezia. Spezia offered several advantages: having its works near the main base of the Italian Navy could make it easier for the fledging plant to undertake not just gun manufacturing, but also reparations and refurbishment works. Moreover, the fact that Spezia was already the seat of military plants and yards, could make it easier to recruit skilled workers and craftsmen. Finally, Spezia lay only 110 kilometres east of Genoa, which was the Italian port were the price of coal coming from Britain was cheaper[21] – and it can be assumed that this was true for every commodity which was shipped through the straits of Gibraltar; transportation costs in Spezia would then be lower than in many other parts of Italy. In order to gain local support, Armstrong's board decided to send 2,000 Lire (£80) to the mayor of Spezia “towards the relief of the poor, who are suffering in consequence of the cholera visitation.”[22]

The firm's board, however, soon changed its mind and started to look for a different place. There is no archival evidence which explains why Armstrong decided to choose another location over Spezia. Given that many local entrepreneurs feared the competition of Armstrong, as it has been reported above, it is possible that Armstrong faced local opposition to setting up its plant there. It is also possible that the armed forces did not like the idea of a foreign-owned plant nearby the

20 G. Jones, *Multinationals and Global Capitalism: from the Nineteenth to the Twenty-first Century* (Oxford, 2005), 148-149.
21 C. Bardini, *Senza Carbone nell'Età del Vapore. Gli Inizi dell'Industrializzazione Italiana* (Milano, 1998), 31-33.
22 T&W 130/1264, *Minutes*, 18 September 1884.

major naval base of the country, or that they were worried that an excessive concentrations of workers could generate political and social risks.

Whatever the reasons, Armstrong's board now focused its attention in the region around Naples. Once again, the management tried to win over the local community: the 8 October it decided to send £160 to the mayor of Naples "to help the poor of the city."[23] The strategy of offering financial support for local welfare projects seems to be a constant of Armstrong's "public relations" policy. Although the only source available to trace these kinds of donations are the minutes of the board – which probably report only the largest payments – it is evident that the company employed again and again the same policy to make itself well accepted. By January 1885 Armstrong had narrowed its options to three places: Castellammare di Stabia (where the Navy managed an important yard) on the south shore of the gulf of Naples, the island of Nisida in front of Bagnoli and Pozzuoli, on the north-west part of the gulf.[24]

In the end Pozzuoli was chosen and on 4 March 1885 the contract between Armstrong and the Italian government was ratified. Pozzuoli lays approximately 15 kilometres west of Naples. It was one of the most important ports in Southern Italy during the Roman age, as impressive ruins testify nowadays, but in 1885 it was a small city of about 12,000 inhabitants, in majority fishermen and farmers.[25] As a location for manufacturing, Pozzuoli presented both advantages and disadvantages. Naples's hinterland being neither very prosperous nor industrialized, could not offer a large pool of skilled workers. Moreover Pozzuoli was not well connected with the main road and rail networks. However, the price of land was low, and the workforce was cheaper than in other, more economically advanced, parts of Italy. Finally, Pozzuoli city council offered tax exemptions to attract Armstrong.[26]

The choice of Pozzuoli was also discussed during a meeting of the Chamber of Deputies in Rome. During the debate, the MP for Taranto, Dayala-Valva, pressed Minister Brin to force Armstrong to establish its works inside the city's arsenal because the naval base could provide a more satisfactory defence for such a strategic plant.[27] All these critics were dismissed by Brin, who repeatedly stressed that Armstrong was free to choose where to establish its plant: this was a private enterprise, he said, without any link with the government, and consequently the Ministry could not impose one location or another. Despite the fact that Dayala-Valva had a political interest in

23 T&W 130/1264, *Minutes*, 8 October 1884.
24 *Inchiesta*, *Relazioni Speciali*, 155.
25 On the history of Pozzuoli R. Annecchino, *Storia di Pozzuoli e della Zona Flegrea* (Pozzuoli, 1960).
26 M. Luongo 'Lo Stabilimento Armstrong di Pozzuoli', *Revue d'Histoire de la Banque* 34-35 (1987), 146-151.
27 Camera dei Deputati, *Atti Parlamentari, Discussioni*, 23 January 1885, vol. 10, 10902-10907.

convincing Brin to press Armstrong to set up its branch in Taranto – this would have meant hundreds of new jobs and an easier re-election for him – it is true that Pozzuoli was vulnerable from naval bombardment. In 1888 Armstrong tried to insure its Italian plant against "war risks" but both the insurance companies it contacted (unfortunately, the board's minutes do not report their names) refused to insure the plant against such a threat.[28] The fact that in 1888 Italian-French relationships were at an all-time low did not help.

Armstrong's board drafted an ambitious plan for Pozzuoli. The cost for the new plant was initially estimated at £145,000, including the purchase of the land, the cost of building, machineries, etc.[29] Armstrong's main goal was to establish a gun manufacturing plant, but the board decided that "the Company reserves … a portion of land in case of shipbuilding being determined upon in the future."[30] In fact, since the beginning, the Ministry of the Navy had encouraged Armstrong to consider the idea of erecting a yard. Mitchell was asked by his fellow directors to produce a plan for a shipyard which was approved by the board. The Board calculated that it would cost at least £23,000 to equip Pozzuoli for shipbuilding.[31] Armstrong was considering replicating in Italy the strategy of integrating different military productions which it had adopted in Britain. The directors also discussed the possibility of starting the manufacture of boilers and naval engines.[32] No final decision was taken, however.

The idea of undertaking shipbuilding was raised for a second time in 1889, in relation to the possibility of buying the Navy's yard in Castellammare.[33] Despite the fact this yard was among the most important shipbuilding centres for the Navy, the government and the Navy wanted to sell it to concentrate the Navy's shipbuilding activities in Spezia and Taranto, which were better protected. This attempted sale, however, did not go through.[34]. During the board meeting of 11 September 1889 the directors discussed "the subject of shipbuilding [...] in connection with Pozzuoli and the proposed purchase of the shipyard of Castellammare. It was agreed to abandon the latter scheme for the reason that the yard was not very capacious, that it was at an inconvenient distance, and it would involve considerable difficulty in management."[35] In the end, the only ships built in Pozzuoli were two gunboats, *Castore* and *Polluce*, which the Italian Army bought from Elswick (later they were

28 T&W 130/1264, *Minutes*, 11 April 1888.
29 Id., 29 July 1885.
30 Id., 15 May 1885.
31 Id., 17 February 1886.
32 Id., 28 January 1886.
33 Castellammare is at the opposite side of the Gulf of Naples, about 40 kilometres as the crown flies from Pozzuoli.
34 F. Degli Esposti, *Le Armi Proprie. Spesa Pubblica, Politica Militare e Sviluppo Industriale nell'Italia Liberale* (Milano, 2006), 177.
35 T&W 130/1264, *Minutes*, 11 September 1889.

taken over by the Navy).[36] The vessels were shipped in pieces to Pozzuoli where they were reassembled. Notwithstanding the fact that no shipbuilding activity was carried there, Armstrong's plant was popularly known as “Cantieri Armstrong” (Armstrong yard).

Meanwhile, the expropriation of the land in Pozzuoli proceeded slowly: the area required was secured only in July 1886. At this point the building work began. Elswick sent both special machinery and a group of technicians to Italy to supervise the erection of the plant: Josephine Butler, the feminist activist, while travelling there, mentioned in a letter that Sir William Armstrong “has sent out of England some 40 or 50 picked men, […] all Northumbrians and choice men in every respect for bodily strength and high character”, to work at his “great ironworks” at Pozzuoli “for making ironclads for the Italian government”.[37]

The distance between Elswick and Pozzuoli also made it difficult to coordinate developments from Newcastle for Andrew Noble, notoriously prone to micromanagement: “Captain Noble reported upon his recent visit to Italy. He considered that it was absolutely necessary for several reasons that Italian directors should be appointed at once.”[38] The directors regarded as necessary the presence *in loco* of an experienced management team, to whom all the operative decisions could be devolved, while Elswick retained strategic planning. Consequently, the board nominated George Rendel (who had been living in Italy for several years, after resigning from the Admiralty for health reasons) and Admiral Albini as directors in charge of the Italian operations. Albini's brief was to run the firm's office in Rome and to take care of the relationships with the Italian Navy: “it was agreed [by the Board] to be desirable that communications with the Italian government should come through the Rome office.” Albini had been for years among the highest-ranking naval officers and he was well-connected with the political *milieu* of the capital. George Rendel, in contrary, could use his engineering skills and his past experience as Elswick's manager to supervise production in Pozzuoli. Albini and Rendel were specifically instructed to try to make arrangements with Terni about the supply of steel for Pozzuoli.[39]

The new directors faced a difficult situation. In Pozzuoli construction activities were proceeding slowly. The board in Newcastle required a fortnightly report to monitor improvements (unfortunately, there is no trace of these communications among the surviving Armstrong's records). In November, Rendel could report that “three heavy cranes were already fixed in the shop. And a

36 P. Brooks, ‘Armstrong and the Italian Navy’, A. Preston (ed.), *Warship 2002-2003* (London, 2003), 108-110.
37 Josephine Butler Archive, The Women Library, London Metropolitan University, 3JBL/25/13, 6 April 1886.
38 T&W 130/1264, *Minutes*, 27 January 1887.
39 Id., 26 May 1887.

large proportion of the machinery required was on the ground." He was still worried, however: he wrote to his brother Stuart that "I have been very busy about Pozzuoli. Things were going altogether to the bad there."[40] Nonetheless a crucial step had been achieved: on 28 July the directors approved the agreement with Terni. Because Armstrong did not to produce steel "in house" at Pozzuoli for the following twenty years, the firm relied exclusively on Terni or on imports from Britain.

The difficulties of working at Pozzuoli were numerous: local workers were untrained to perform many common industrial tasks, activity was often slowed down by the lack of coherent direction, and linguistic barriers made everything more difficult.[41] The seriousness of the problems can be assessed by the unanimous resolution that the directors passed in praise of the work of their fellow colleague colonel Dyer:

> Colonel Dyer having now returned from Pozzuoli after an absence of nearly eight months, and having there rendered at great personal inconvenience and discomfort, as well as risk to health, most important services to this Company by organising the establishment and correcting abuses, the Directors thank it right to express their obligation to him for so ably performing the duty which he undertook at the request of his co-directors.[42]

During a special meeting on 16 April, the directors discussed the state of Pozzuoli. From 1885 to 1887, Elswick had authorised expenditures worth 5,350,000 Lire (£214,000) for the establishment of the plant. The board approved the additional sum of 3,500,000 (£140,000) Lire for 1888.[43] The total sum, £354,000, doubled the estimate made three years before. Costs had been initially underestimated and, at the beginning, construction activities suffered from mismanagement, however, after years of troubles, in 1888 the main buildings and machinery were in place. As a sign of the fact that the plant could now be run in a more traditional fashion, and that frequent trips from Elswick's directors were not required any more, the board appointed captain De Luca, a former Navy officer, as residential sub-manger, Rendel having made explicit his desire to

40 T&W Archive, 31/2998, 13 December 1887.

41 The memories of Herbert Rowell, a young engineer who worked in Pozzuoli to supervise the construction of *Castore* and *Polluce* offers a testimony of these difficulties. While Rowell's vision of Italy and its inhabitants is undeniably "orientalistic", his recollection conveys the magnitude of the problems faced by Armstrong's management in setting up Pozzuoli. See E. Rowell (ed.), *In Peace and War. Tyneside, Naples and the Royal Flying Corps* (Otley, 1996), 62-94.

42 T&W 130/1264, *Minutes*, 31 May 1888.

43 Id., 16 April 1888.

retire as soon as possible. While De Luca's position was subordinated to Albini's Roman office, it represented the first stable management enjoyed by Pozzuoli. Newcastle, however, kept monitoring the Italian branch carefully: “no orders for machinery or work of any kind on capital account be given without the authority of the Board.”[44]

Pozzuoli, however, suffered from lack of orders. This was because Armstrong was slow to shift Italian orders from Elswick to Pozzuoli. While there is no documentation explicitly addressing this issue, several reasons probably contributed to this: the slowness in the erection of the new works certainly extended the period before it became possible to move production to Italy; in addition, Elswick's management probably deferred the transfer of orders to keep its British plant working at full capacity, rather than lose part of its production to the foreign branch. Finally, the lower costs and higher productivity of Elswick allowed hardware to be sold to the Italian government at a higher profit, reducing the incentives to move production to Pozzuoli. Brin had been pressuring in this direction since late 1887 when, speaking with Albini, he had pointed to the desirability of having “Pozzuoli in working order at the earliest possible date, and of having some manufactured work to show.”[45] In a letter dated 25 April 1889 a resentful George Rendel wrote that “Pozzuoli goes on as well as it can with a lack of work … and it appears at first sight then utterly unjustifiable that Pozzuoli should have to discharge men while Elswick is stuffed with Italian work … We have now many of the new machines requested by De Luca in place and ready for work, and ought to be taking men on”.[46] At the same time the management had to refuse works that Pozzuoli could not carry out:

> A letter from Messrs Crampa & Trigli of Sorrento was read asking the Company to take an order for a sailing ship to be built at Pozzuoli. The Secretary was desired to express the regret of the Directors that their present arrangements did not admit building vessels.[47]

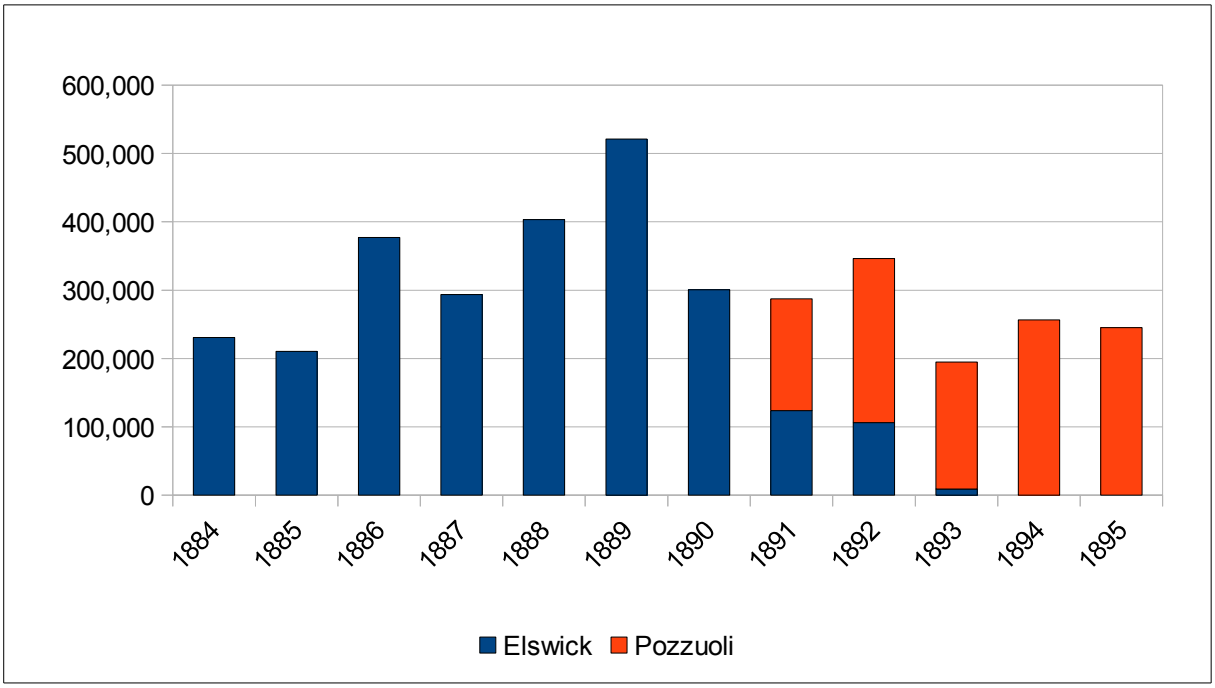
A positive assessment of Pozzuoli came in 1889 from an official report commissioned by the Ministry of the Navy “on the conditions of the metallurgic, mechanical and naval firms in Italy” redacted by Antenore Bozzoni, who had worked with Brin in the Enquire Committee on Mechanical

44 Id., 27 January 1889.
45 Id., 23 November 1887.
46 T&W Archive, 31/3582, 25 April 1889.
47 T&W 130/1264, Minutes, 22 August 1888.

Industries some years before. Bozzoni pointed to the fact that the Armstrong's plant in Pozzuoli provided Italy for the first time with a "mechanical industry of special character, that is the manufacture of guns and of all the attachments and mechanisms needed for their operation." Moreover the plant, despite not yet finished, generated "the impression of an English shop transplanted in Italy, for the correctness of its layout, for the perfection of its machinery, and for that ensemble of order and work distribution which form a distinctive character of industries exercised by people of long practice and experience."[48]

From 1890 Italian orders started to be executed in Pozzuoli. Figure 5.3 shows the advances received by Elswick for Italian work in progress undertaken at both Elswick and Pozzuoli. Until 1890 all Italian orders were executed in Elswick. From that year, Pozzuoli acquired a rising proportion of the Italian orders (as Elswick was completing the backlog of orders still in hand), and from 1892 all Italian orders were executed in Pozzuoli. Judging from this yardstick, Brin's policy had been clearly successful: Italy had acquired within a few years a gun plant which could satisfy all the Navy's requests for large, medium and small ordnance.

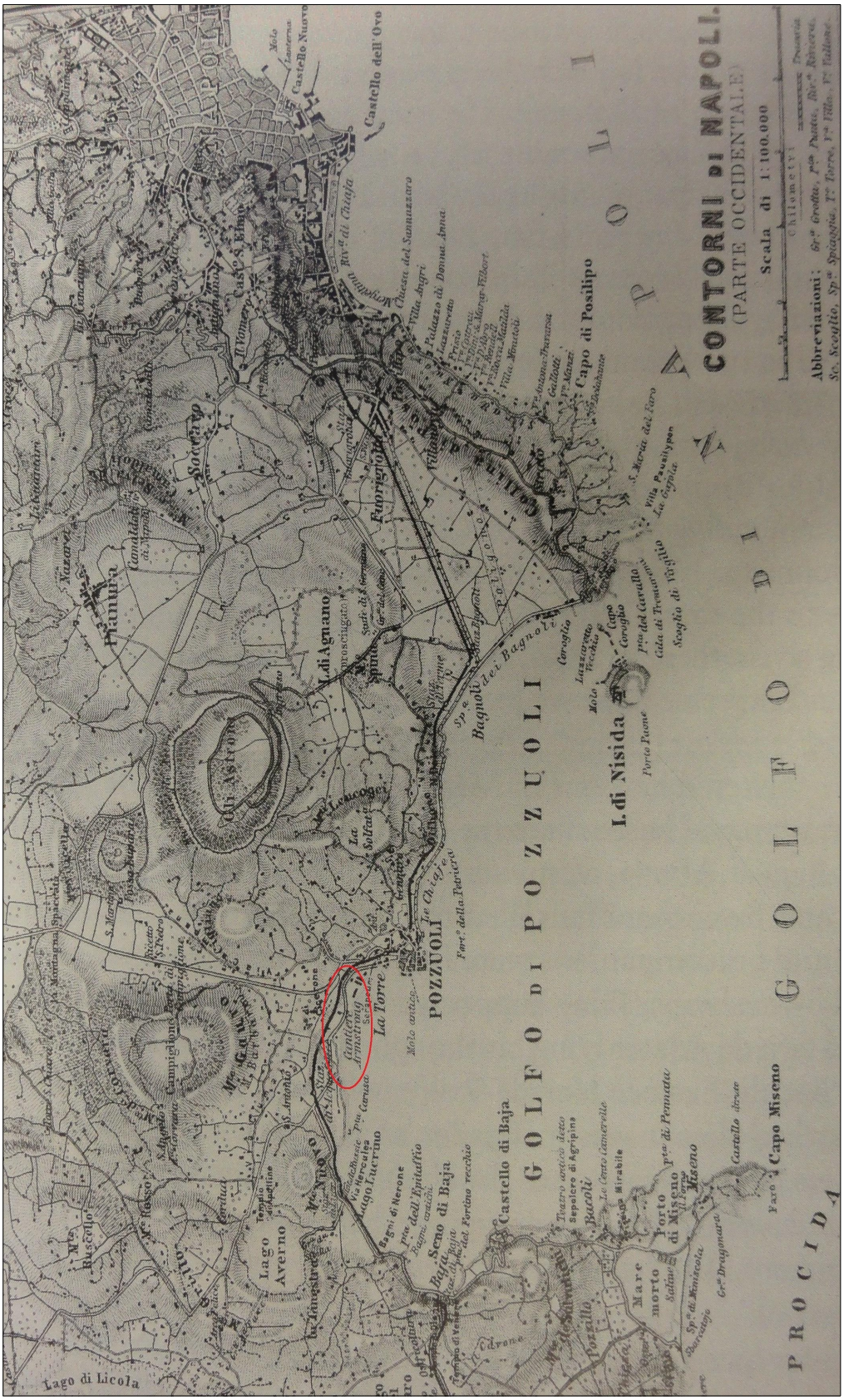
Figure 5.3: Advances paid by Italy for work in progress at Elswick and Pozzuoli, 1884-1895 (in current pound).



Source: Figure 5.1.

48 *Relazione a S. E. il Ministro della Marina sulle Attuali Condizioni delle Industrie Metallurgiche, Meccaniche e Navali* (Roma, 1889), 40-47.

Figure 5.4: Map of the region west of Naples. The “Cantiere Armstrong” is highlighted in red.



Source: Wikimedia Commons.

In 1890 the outlook for Pozzuoli looked therefore more positive: George Rendel informed the board that "[he] was of opinion that the most serious difficulties connected with the starting of the establishment had now been overcome, and that notwithstanding the extra cost of taxation, supervision, and fuel, and the inexperience of the workmen, he had no fear of remunerative orders being received".[49] For the period 1890-1895 it is possible to provide a detailed analysis of the activities and investments carried on at Pozzuoli, thanks to the data reported in Armstrong's balance books. Expenditures were divided into five categories: land, buildings, machinery, tools and loose plant and furniture and other expenditure.

Figure 5.5: Expenses to date on land (in current pounds).

Expense	Value	Percentage change year on year
at 30 June 1891	20,910	-
at 30 June 1892	22,225	6.3 %
at 30 June 1893	25,056	12.7 %
at 30 June 1894	25,054	0 %
at 30 June 1895	25,192	0.5 %

Source: 130/1337-1341.

Figure 5.6: Expenses to date on building (in current pounds).

Expense	Value	Percentage change year on year
at 30 June 1891	152,935	-
at 30 June 1892	161,436	5 %
at 30 June 1893	161,457	0 %
at 30 June 1894	164,175	1.6 %
at 30 June 1895	164,186	0 %

Source: Figure 5.5.

49 T&W 130/1264, *Minutes*, 24 July 1890.

Figure 5.7: Expenses to date on machinery (in current pounds).

Expense	Value	Percentage change year on year
at 30 June 1891	154,088	-
at 30 June 1892	160,997	4.5%
at 30 June 1893	162,509	0.9%
at 30 June 1894	166,803	2.6%
at 30 June 1895	172,364	3.3%

Source: Figure 5.5.

Figure 5.8: Expense to date on tools and loose plant (in current pounds).

Expense	Value	Percentage change year on year
at 30 June 1891	14,518	-
at 30 June 1892	17,284	19%
at 30 June 1893	18,507	7%
at 30 June 1894	19,367	4.6%
at 30 June 1895	18,667	-3.6%

Source: Figure 5.5.

Figure 5.9: Expense to date on furniture and other (in current pounds)

Expense	Value	Percentage change year on year
at 30 June 1891	2,354	-
at 30 June 1892	2,141	-9%
at 30 June 1893	1,928	-9.9%
at 30 June 1894	1,733	-10.1%
at 30 June 1895	1,551	-10.5%

Source: Figure 5.5.

Figure 5.10: Total expenditure to date at Pozzuoli (in current pounds).

Expense	Value	Percentage change year on year
at 30 June 1891	344,808	-
at 30 June 1892	364,086	5.6%
at 30 June 1893	369,458	1.5%
at 30 June 1894	377,134	2%
at 30 June 1895	381,962	1.3%

Source: Figures 5.5-5.9.

The construction period resulted in an impressive plant: the main shop covered an area of 13,000 square meters, and it was served by 16 travelling cranes, whose power ranged from 5 50 70 tons. The works were powered to the amount of 400 horse power.[50] After this initial wave of spending, however, the investment trend was quite flat. This was predictable for expenditure on lands and buildings: the company did not expand and therefore little expenditure was needed. In contrary the trend in machinery and tool investment was more positive but the general impression is that the firm's directors economised on investments. Because in the course of the 1890s references to Pozzuoli became less and less numerous in the minutes of the board, it is impossible to assess to what extent it was the Newcastle's head office which opposed new investments or if it was the local management which did not see the need for additional expenditures. It is sure, however, that Elswick's directors were unwilling to commit large sums to Pozzuoli. Later on, this lack of investment was considered to have been a mistake.

Poor final year results were the reason why Armstrong became dissatisfied with its Italian investment (Figure 5.11). Until 1891 Pozzuoli did not make any profit. Armstrong had incurred in large expenditure to erect the plant in the previous five years, and the works were only slowly starting production; more troublesome was that also in the following five years Pozzuoli's profits were disappointing. The picture becomes still less satisfactory if the return on the expenditures are considered. Because of its poor results, Pozzuoli contributed little to Armstrong's total profit, with a peak of 6.7% in the year 1893-1894. The decline in the Italian naval budget which started in 1890 was the major cause of the unsatisfactory results. Pozzuoli was completed exactly when the Italian

50 *Arms and Explosive*, July 1895, 169.

Navy had to cut the ambitious construction plan it had devised in the 1880s: naval shipbuilding did not stop, but investments in new construction declined considerably. As a result, Pozzuoli suffered from diminished orders, after the backlog of works ordered until the late 1880s was cleared.

Figure 5.11: Final year results of Pozzuoli 1891-1896 (in current pounds).

Profit	Profits (losses)	Return on expenditures	Pozzuoli's profits as % of Armstrong's total profits
at 30 June 1891	(15,721)	- 4.6%	-
at 30 June 1892	9,974	2.7%	3.5%
at 30 June 1893	7,463	2%	2.5%
at 30 June 1894	22,100	5.9%	6.7%
at 30 June 1895	19,074	5%	5.5%
at 30 June 1896	14,442	-	-

Sources: T&W, 130/1337-1342.

Figure 5.12: Work in progress in Pozzuoli, 1887-1895 (in current pounds).

Year	Work in progress
at 30 June 1887	5,077
at 30 June 1888	17,866
at 30 June 1889	53,897
at 30 June 1890	78,910
at 30 June 1891	111,164
at 30 June 1892	242,262
at 30 June 1893	280,553
at 30 June 1894	345,671
at 30 June 1895	313,490

Source: T&W, 130/1333-1341.

The series on the work in progress in Pozzuoli survive for the years 1887-1895. It displays a more marked rising trend, in line with the tendency to move to Pozzuoli production carried out for the Italian Navy. However, the fact that orders did not result in a satisfactory level of profits raises doubt about the efficiency of the works.

In 1896 Armstrong opted to reconstruct the Italian branch as an autonomous company – the Armstrong Pozzuoli Company Limited – which was entirely owned by Armstrong. Unfortunately the records of the Armstrong Pozzuoli Company have been lost and therefore much less information is available for the period 1896-1914. The land, buildings and machinery situated in Italy were transferred to the new company, which had a capital of £185,000, divided into 18,500 shares, of £10 value.[51] The directors of the Armstrong Pozzuoli company were the same as those of the Armstrong Company.[52] An autonomous company could more easily enter into agreements or amalgamate with other Italian firms, without involving Armstrong's capital. Brin had already raised for the first time in 1889 the issue of the desirability of "employing Italian capital" at Pozzuoli to reduce the "foreign" character of Pozzuoli in the eyes of Italian public opinion.[53] Armaments was a sensitive sector, one in which the nationalistic card could be used to damage competitors. In general, Elswick's interest in Pozzuoli seems to have declined: as Armstrong now received a fixed payment from Pozzuoli (initially £16,000, which was reduced to £13,000 after two years) rather than more directly participate in any profits or losses, there was little incentive for it to invest substantial sums of money to improve Pozzuoli. Another sign of the falling importance of Pozzuoli in Armstrong's strategy was that there were virtual no reference to it in the minutes of the board's meetings between 1896 and 1900.

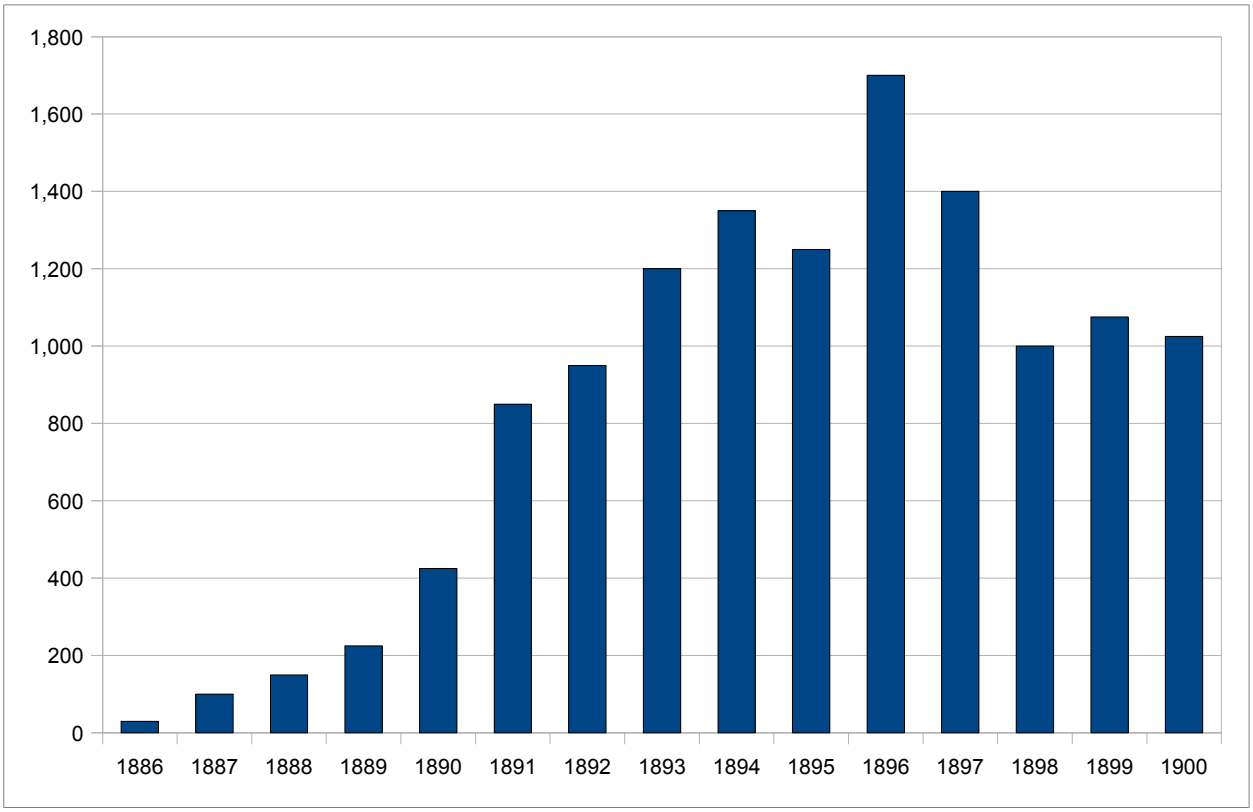
5.3 *Pozzuoli in the late 1890s and the problem of steel supply.*

Pozzuoli, as all the other Italian firms in the armaments sector, suffered from the fall of orders from the Italian Navy. Unfortunately, the loss of Pozzuoli's balance sheets has deprived us of much relevant information and statistics about the period after 1895. However, data on output (Figure 5.13) and on the total number of workers (Figure 5.14) can be found in an official volume published for the fifteenth anniversary of the foundation of the Armstrong Pozzuoli Company in

51 NA, Board of Trade 31/31793/46622, 23 January 1896.
52 T&W, 130/1265, *Minutes*, 23 January 1896.
53 T&W, 130/1264, *Minutes*, 29 May 1889.

1911.[54]

Figure 5.13: Pozzuoli's total output of ordnance, 1886-1900 (in tons).



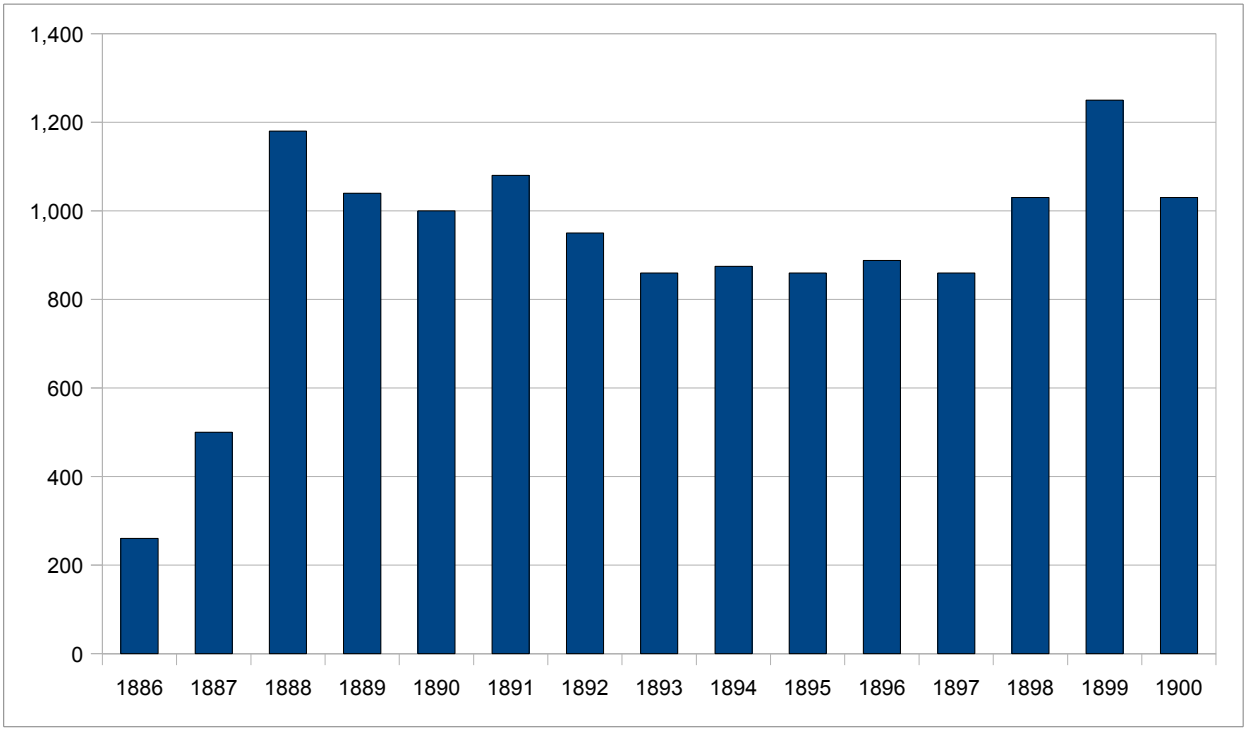
Source: *Stabilimento Armstrong*, 145.

Figure 5.13 shows the temporal hiatus between the trends of naval budget and the firm's output. Output rose until mid 1890s as a consequence of the delayed beginning of production of orders already signed. After 1896 production declined and remained flat until the end of the century. During the second half of the 1890s, dwindling orders from the Italian Navy were partially compensated by supplying the guns for the ships which Italian yards built for foreign governments. All the *Garibaldi* were armed with Pozzuoli's guns, for instance.[55] In contrary, until the 1910s no order came for the Army. Figure 5.13, however, do not divide production in different typologies of guns, but consider its total weight. Therefore it is not possible to ascertain what kind of guns were

54 *Lo stabilimento Armstrong di Pozzuoli dal 1896 al 1911* (Bergamo, 1911).
55 *Stabilimento Armstrong*, 6.

produced in a certain year.

Figure 5.14: Number of workers employed at Pozzuoli 1886-1900.



Source: *Stabilimento Armstrong*, 173.

Data on the number of workers employed (figure 5.14) followed a different trend: after an initial large increase caused by the erection activities, Pozzuoli's workforce declined to less than 1,000 workers. The excessive number of men became evident within a few years after the creation of the plant. As early as 1891 Armstrong's board "agreed that a general reduction in the Pozzuoli staff was imperative".[56] It is interesting to notice how there was no positive correlation between, on the one side, the output of guns and on the other side the number of workers. The production of ordnance was a difficult task, that required skills and competence. It was thus possible to produce more but with a smaller, more experienced, and more productive labour force.[57] This is confirmed by a note in the Minutes of the meeting of the Armstrong's Board:

56 T&W, 130/1264, *Minutes*, 30 September 1891.
57 Unfortunately we do not know know if Pozzuoli's workers were paid by the piece or if other financial incentives were used to raise production.

> Mr Cruddas laid on the table the report of the auditors [about] working expenses for 1890 and 1891[at Pozzuoli]. He read some extracts showing that the men had been reduced from 1120 to 919 in the course of nine months, and that a further reduction of 100-150 was aimed at. The reduction of men, said the auditors, appeared favourable to the work, as more work was done with 1/5 less men. Some comments followed upon the unsatisfactory retention in our employ officials for whom there seemed no work.[58]

Armstrong's management repeatedly tried to use the threat of a reduction of the workforce to put pressure on the Ministry of the Navy and gain additional orders. For instance, in a letter date 2 November 1897, the local manger De Luca wrote to the Minister that:

> I'm sad to inform you that we are forced to fire at the end of the next months 300 workers because there is no work, and in the following months we will have to carry on further significant reductions of personnel. We cannot hope for a remedy other than in your benevolent intervention, in order to help these good workmen we are force to dismiss, orders in advance for guns for vessels which will be commissioned.[59]

Another contentious issue for Pozzuoli were the cost and availability of steel. After the adoption of steel ordnance, the problem of gaining supplies of high quality steel had become crucial. Special requirements of strength, toughness and resistance, made common steel unsuitable. Prior to the creation of Terni there was no plant in Italy capable of producing the kind of steel required for military purposes. As said before, a clause in the contract Armstrong signed with the Italian Navy to create Pozzuoli, awarded an increase of price in case Pozzuoli made use of Italian steel, that is Terni's steel, because Terni enjoyed a virtual monopoly in the special steel alloys for military purpose.

The quality of the gun forgings purchased from Terni was satisfactory: Andrew Noble defined Terni's steel as “good”.[60] However Terni's steel was not cheap. Armstrong suffered from this in two ways. First, because Pozzuoli paid a high price for steel, it had to charge a higher price for

58 T&W, 130/1264, *Minutes*, 29 June 1892.
59 ACS, Fondo Marina Militare, Direzione Generale d'Artiglieria ed Armamenti, b. 115, f. 162, 2 November 1897.
60 T&W, 130/1264, *Minutes*, 9 May 1894.

the finished gun. Although the higher cost of steel could be passed entirely onto the final price paid by the government, this meant that the Italian Navy could buy fewer guns, *ceteris paribus*. Second, higher prices made guns produced at Pozzuoli more difficult to export. As Pozzuoli faced diminishing orders from the Italian Navy, the problem of steel became more relevante because Pozzuoli could only increase its order book by obtaining contracts from foreign governments.[61]

In the absence of Pozzuoli's records, the fragmented and uncatalogued records of the Ministry of the Navy make it possible to assess some of the difficulties Pozzuoli faced in gaining foreign customers. The Ministry's records document the efforts made by Pozzuoli to gain the order for the guns for the Portuguese light cruiser *Adamastor* which had been laid down to the Orlando shipyard in Leghorn in 1895.[62] The management of Pozzuoli, hoping to secure the contract, started to lobby the government in Lisbon.[63] Eventually, however, the contract went to Krupp. Disappointed that the contract had not been awarded to the only Italy-based ordnance company, notwithstanding the fact – as the Italian *charge d'affaire* in Lisbon complained to the Foreign Minister – that the Italian government had loaded Portuguese politicians and military officers with chivalry orders and decorations in every possible occasion,[64] the Ministry of the Navy decided to investigate, and asked Pozzuoli and Terni their opinion of why the order had been awarded to Krupp.

The two companies offered very different assessments of what had gone wrong. Pozzuoli's management believed that the key problem were high costs of production. In fact "the cheapness of the work force in Pozzuoli is compensated by the major burdens inherent to Pozzuoli, that is higher taxes, a higher cost of power [i.e. coal] and higher costs for the use of machinery." The essential issue, however, was the cost of steel. In fact "the tariff duty of 9 lire for quintal [for English steel], while not being prohibitive, is enough to influence the acquisition of orders from abroad … About manufacturing guns with Terni's steel, Your Excellency knows its prices."[65] If Krupp had secured the contract it was because it offered the Portuguese government a better deal. If the Italian government wanted to help Pozzuoli gaining orders from abroad, maintain the plant busy and the

61 Article n. 14 of the contract between Armstrong and the Italian government allowed Pozzuoli to satisfy orders coming from foreign governments, provided that these were in "friendly relationships with the Italian government".

62 The documents relevant for this transaction can be found in ACS, Fondo Marina Militare, Direzione Generale Artiglieria ed Armamenti, b. 115, f. 5. This ship played a significant role in Portuguese history: during the Republican Revolution of 1910 its mutinous crew shelled the Royal Palace forcing King Manuel II to leave the country, *The Times* 8 October 1910, 5.

63 ACS, Fondo Marina Militare, Letter from Armstrong's Office in Rome to the Portuguese Ministry of the Navy, 22 June 1895.

64 ACS, Fondo Marina Militare, Letter from the Italian Legation in Lisbon to the Foreign Minister Visconti Venosta, 16 August 1897.

65 ACS, Letter from Armstrong's Italian Office to the Ministry of the Navy, 12 June 1895.

workers employed, the solution was either to reduce the duty on imported steel, or to convince Terni to reduce its prices. Terni's technical office replied offering a completely different assessment.[66] Terni's steel could be more expensive, it conceded, but this was only because orders were usually small and discontinued. As a result, it was difficult to take advantage of the economies of scale which, otherwise, could have contributed to reduced the price of steel. Additionally, Terni pointed to the fact that "it is not the first time that the reluctance to make use of Terni's steel by several companies, and of Armstrong in particular, has been noticed." Complaining about the price of steel was just a strategy because "it seems that Armstrong has the interest to send to Elswick, as far as it is possible, the orders for complete guns or, at least, to avoid the constraint to buy from national [i.e. Italian] suppliers to favour Elswick and its production."

Even though in this specific case it is possible that politics played a role – Portugal, after the 1890 clash with Britain for the possession of the large territory lying between Angola and Mozambique,[67] was in no mood to buy from British-owned companies – the problem of the high cost of Terni's steel was a real one, as it is testified by another round of letters exchanged between Terni, Pozzuoli and the Ministry the following year. On 25 March 1898 the Department for Ordnance and Armaments of the Ministry of the Navy wrote a message to the Navy technical office in Terni.[68]

> This Ministry, having several times asked Armstrong a discount on the quite high prices that it charges, has always received the answer that this discount could not be granted, because of the difference between the prices of Terni's steel and English one; and the company said that it could charge better prices only if the Ministry would give up the provision that force Armstrong to use Italian steel and so allow it to use English steel.[69]

The Ministry asked Terni to provide its own data on the price of steel. The relevance of the topic is testified by the fact that the letter was signed by Benedetto Brin himself, at that time for the fifth and last time Minister for the Navy. Moreover, the paper was labelled "confidential": Brin was aware that this issue was a potentially dangerous one because of the many controversies that

66 ACS, Letter from Terni's Technical Office to the Ministry of the Navy, 14 September 1897.
67 R. Hammond, *Portugal and Africa, 1815-1910: a Study in Uneconomic Imperialism* (Stanford, 1966), 100-132.
68 The Italian Navy had offices inside all major armaments companies with the task to verify the quality of final production. There was a similar office in Pozzuoli.
69 ACS, Fondo Marina Militare, Direzione Generale d'Artiglieria ed Armamenti, b. 160, f. 1286, 25 March 1898.

surrounded Terni and its relationship with the Navy. Therefore he did not want to provide Terni's critics with the information presented in the document. Figure 5.15 shows the unitary prices and the prices/weight ratio of different kinds of guns and carriages that Pozzuoli had sold to the Navy and the prices of comparable kind of artillery which the Army had obtained from Armstrong or other private manufacturers.

Figure 5.15: Price paid by the Italian Navy and the Army for selected pieces of ordnance and carriages.

	Unitary price (in lire)	Weight (kilograms)	Price/Weight (in lire)
Artillery			
Krupp gun type "9" for the Army	4,360	482	8.862
Armstrong gun type "57"	7,500	365	20.548
Armstrong gun type "76"	10,300	600	17.166
Armstrong gun "120.A.91"	22,000	2,120	10.377
Carriages			
Gruson carriage "12" for the Army	7,472	5,105	1.464
Armstrong platform carriage "120"	17,546	3,490	5.0275
Armstrong siege carriage "15" for the Army	5,000	1,898	2.634
Armstrong platform carriage "152.A.91"	34,500	5,955	5.793

Source: ACS, Fondo Direzione Generale d'Artiglieria ed Armamenti, 25 March 1898.

Such a comparison should be taken with a pinch of salt: naval ordnance tended to be more expensive than land artillery because it was more sophisticated (all technical innovations in artillery in the period 1860-1914 came from naval guns, and only subsequently were applied to land artillery). This was especially true for gun mountings, platforms and carriages which were much more complex in the case of naval ordnance. In addition, it was possible that companies other than

Figure 5.16: Comparison of the cost of guns and carriages made by Armstrong with that by the Spezia arsenal.

Gun or carriage	Weight (kilograms)	Manufacturer	Average cost of materials	Average cost workforce	Average total cost	Increase of 75% on workforce cost	Total Cost	Cost/Kilo
Gun "A.91", gauge 152 mm	6,615	Department	30,383	4,890	35,273	3,667.5	38,940.5	5.89
		Armstrong's	-	-	-	-	51,000	7.71
Platform carriage type "Piedmont" for gun gauge 152 mm	8,588	Department	14,278.2	4,948.92	19,227.12	3,711.69	22,938.81	2.67
		Armstrong's	-	-	-	-	26,065.805	3.035
Gun "A.91" gauge 120 mm	2,120	Department	13,173	2,380	15,553	1,785	17,338	8.178
		Armstrong's	-	-	-	-	22,000	10.377
Platform carriage type "Piedmont" for gun gauge 120 mm	3,490	Department	7,780.54	3,888.52	11,669.06	2,916.39	14,585.45	4.179
		Armstrong's	-	-	-	-	17,546	5.027
Carriage type "Umberto" for gun gauge 120 mm	2,821	Department	9,902.9	2,287.08	12,189.98	1,715.31	13,905.29	4.929
		Armstrong's	-	-	-	-	18,046.805	6.397
Gun gauge 57 mm	338	Department	3,117.5	787	3904.5	590.25	4,494.75	13.928
		Armstrong's	-	-	-	-	7,612	22.52

Source: ACS, Fondo Direzione Generale d'Artiglieria ed Armamenti, 17 May 1898.

Armstrong were trying to sell at a low price in order to gain entrance into the Italian market. Nevertheless, it is quite evident that Armstrong's hardware was systematically more expensive than that produced by competitors; the price/weight ratio is especially revealing on this. In addition, the naval department for ordnance and armaments submitted another document on 17 May 1898. This time the prices of some of Armstrong's guns and carriages were compared with the cost of manufacturing similar hardware manufactured in the Navy's own gun plant inside the Spezia arsenal (Figure 5.16). To allow a meaningful comparison between the activities of a private firm and that of a public establishment, an arbitrary mark-up equal to 75% of the workforce cost was added to the costs of materials and workforce sustained by arsenals to account for profit, depreciations, amortizations, investments, and other costs which a private firm sustained but which were not included in the accounting data of arsenals.

This comparison was again partially unfavourable to Armstrong. All the type of guns or carriages considered in the figure could apparently be produced more cheaply by the Navy than by Armstrong. Again, however, the numbers need to be treated with care. The arsenal's administration had a clear interest in presenting a rosy picture of its activity, a positive assessment which was not shared by every Italian military expert.[70] Moreover, it is unknown if the quality of the products was comparable. What is more, the value of the mark-up added to equalise arsenal production with that of private firms might be too small to properly account for all the non operative costs faced by Pozzuoli. Finally, the list only comprises small to medium calibre guns, while Italian arsenals could not manufacture large calibre naval guns, which represented the major offensive armaments of warships. Therefore, also if arsenals might be competitive in the production of small calibre artillery – and this is doubtful – they could not compete with Armstrong in the most advanced and profitable market niche. Armstrong's management was able, however, to justify its prices by blaming the high cost of the steel. It sent to the Ministry data to show how expensive was Terni's steel in comparison with British one (Figure 5.17).

How to make sense of all these different, and conflicting, numbers? There is no doubt that Armstrong, Terni and the Italian arsenal administration all cherry-picked data to support their own positions. One point, however, seems beyond dispute: Terni's steel was generally more expensive that comparable British steel. As a consequence, the Ministry of the Navy wrote again to Terni asking for reductions in the price of steel. The letter ended with a veiled threat: “If the steel works at Terni will continue to maintain high prices, the Ministry will be forced to authorize Armstrong to

70 Degli Esposti, *Armi Proprie*, 334-337 for the contrasting evaluations on the quality of arsenals' products expressed during parliamentary debates in the second half of the 1890s.

use English materials."[71]

Figure 5.17: Comparison of the prices of several guns and carriages made by Armstrong's using Italian or British steel (in Lire).

Kind of guns and carriages	305 mm/40 gauges gun	203 mm/45 gauges gun	152 mm/45 gauges gun	76 mm/40 gauges gun	47 mm/40 gauges gun	Four 305 mm guns structure without casemate	Steel nickel casemate for four 305 mm guns structure	Two 203 mm guns structure without casemate	Steel nickel casemate for two 203 mm guns structure	Carriage for 76 mm gun
Price using Italian material	303,300	122,200	54,800	9,700	7,310	1,782,100	628,500	308,100	242,900	8,800
Price using British material	265,050	108,050	47,000	8,700	6,990	1,744,450	551,000	290,000	196,000	8,650
Difference	38,250	14,150	7,800	1,000	320	37,650	77,500	18,100	46,900	150
Price % increase if Italian material is used	14.43%	13.10%	16.59%	11.49%	4.57%	2.16%	14.065%	6.24%	23.93%	1.85%

Source: ACS, Fondo Direzione Generale d'Artiglieria ed Armamenti.

5.4 C*onclusions.*

Italy had been among the most important customers for Elswick since the first years of the firm. The Italian government had been happy for two decades to buy from Armstrong what it required to arm its Navy. At the beginning of the 1880s, however, a combination of growing military expenditures, increased international frictions with France, and new mentalities among high-ranking naval officers led to a change in strategy. The Italian Navy had now the possibility of driving a bargain with Armstrong: Italy would still be a loyal customer of Armstrong (and Italy was a very important customer for Elswick during the first half of the 1880s) if the firm accepted to build a plant somewhere in Italy. It was the concern of losing such a potentially lucrative market

71 ACS, Fondo Direzione Generale d'Artiglieria ed Armamenti, b. 160, f. 860, 28 June 1898.

which convinced Armstrong to undertake the Italian investment, something which the firm had refused to do in the previous decades. The ambitious hopes Armstrong had for Pozzuoli rapidly vanished, however: managing a plant in a different country, thousands of kilometres away, proved to be a daunting challenge. Many problems plagued the initial years of Pozzuoli until a more suitable management framework was devised with local managers dealing with production, while the strategic planning decisions were left in the hands of Armstrong's board in Newcastle.

By the time Pozzuoli achieved full production, Italian military spending had entered a period of decline and stagnation. The naval budget was cut, and funds for new constructions were sacrificed. Pozzuoli was badly affecting. Consequently, Armstrong's board abandoned any idea of expanding Pozzuoli into other fields, such as shipbuilding. Additionally, Armstrong's Italian branch found itself involved in controversies with the Navy about the price of its guns. With dwindling resources devoted to the Navy, Terni, Pozzuoli and the government arsenals battled to retain the largest share of the available resources. The relevance of Pozzuoli, and the importance of Italy as a customer, was further diminished in the eyes of Elswick by the rapid growth of British naval expenditure over the same period, an expansion which offered very large orders and returns.

Fifteen years after the contract for the creation of Pozzuoli had been signed, Italy had freed itself from the need to buy abroad the guns required for its warships. Brin's strategy had been successful, although at the cost of higher prices. At the same time, however, Pozzuoli could hardly be called an indisputable commercial success.

Chapter VI

Acquisitions and Dreadnoughts: the British Armaments Industry, 1897-1914

This chapter analyses the evolution of the British armaments industry from 1897 to 1914. In this period, British armaments companies accelerated the process of vertical integration which had begun in the previous decades. The aim was that to acquire the capability to autonomously produce all the key components of a warship: hulls, guns and armour plates. The years 1897-98 can be taken as a watershed: within a few months, Vickers and Armstrong made large acquisitions, entering new areas of production. John Brown and Cammell rapidly followed by purchasing shipbuilding firms and, in the early 1900s, by forming a third private ordnance firm, the Coventry Ordnance Works (C.O.W.). In these years, British armaments firms retained a leading position in the international armaments trade, but, in contrast with the previous decades, they became involved in setting up branches and joint-ventures abroad.

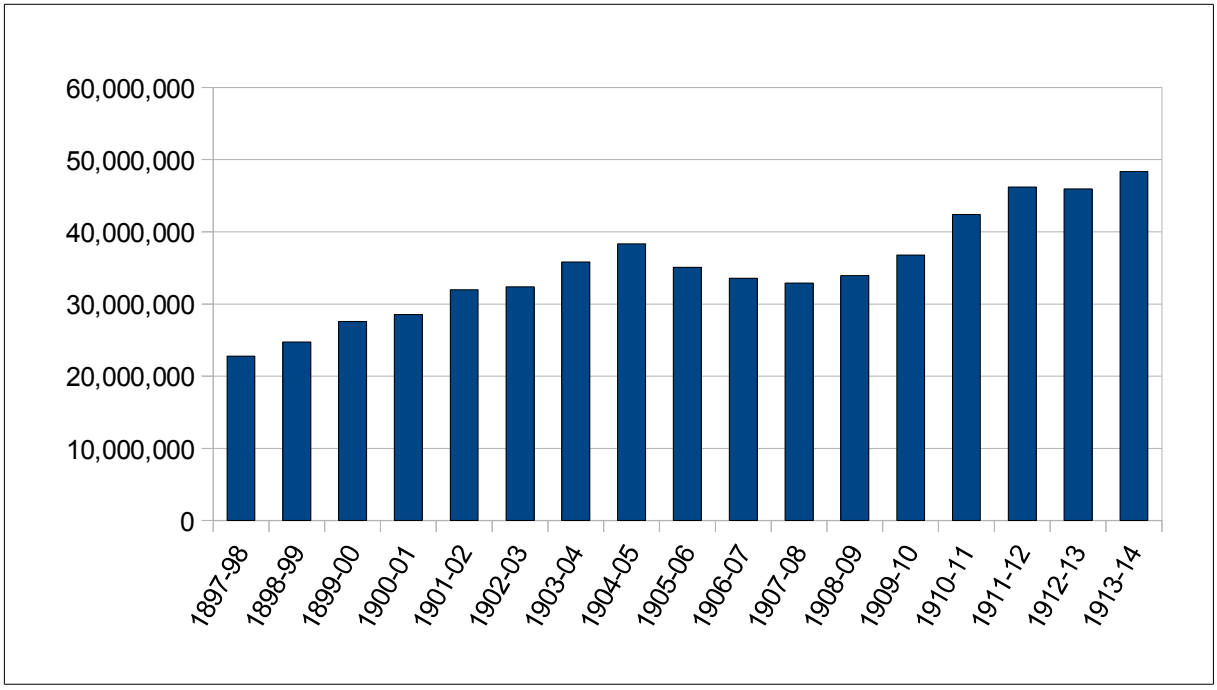
The chapter is organised as follow: the first part summaries the trend of British naval spending; the second deals with technical evolution; the third part analyses armaments firms' strategies and results.

6.1 *British naval spending, 1897-1914.*

In the years 1897-1914, the British naval budget more than doubled, from 22.8 million to 48.3 million pound (figure 6.1). Growth, however, was not even. Three different phases can be identified. The first one, from 1897-98 to 1904-05, was the continuation of the previous quinquennial: naval spending increased year after year, at an average annual rate of 7.8% until, by 1904-05, it arrived at more than 38 million pound. During thee second period, from 1905-06 to 1907-08, the naval budget was cut each year. The reduction was especially large (-8.5%) in 1905-06 while cuts were less drastic in the following two years. As a result, on 1907-08 naval spending was

back at the 1902-03 level, around 32.5 million pound. In the third period, from 1908-09 to the beginning of the First World War, the British naval budget started to expand again, at an annual average rate of 6.7%, peaking in 1913-14 (the last budget unaffected by the war) at more than 48 million pounds, an increase of 16 million in six years.

Figure 6.1: British naval spending, from 1897-98 to 1913-14 (in current pounds).



Source: *Navy Estimates*, HCPP, various years.

Until 1904, the Royal Navy's most likely enemy were the combined fleets of France and Russia.[1] In this context, every expansion of French and Russian naval budgets was counteracted by increases in British defence expenditure. For example, British naval estimates for 1897-98 financed the construction of the Royal Navy's first six armoured cruisers (cruisers which had armour plates protecting their sides, and not only their decks) as a direct response to cruisers of the same type which both France and Russia had start laying down. The following year, the British naval budget was increased again to respond to a new Russian plan which provided resources for the construction of seven battleships, nineteen cruisers and fifty smaller crafts.[2] Such "tit for tat" dynamic was the

1 A. J. Marder, *The Anatomy of British Sea Power: a History of British Naval Policy in the Pre-Dreadnought Era, 1880-1905* (London, 1964), 576-581.
2 A. J. Watts, *The Imperial Russian Navy* (London, 1990), 18.

reason behind naval expansion.[3] The Second Boer War, fought between 1899 and 1902, highlighted how crucial maritime power was for Britain. South Africa is thousands of miles away from the British islands and the British government sent there an expeditionary forces of more than 200,000 men. The Royal Navy played two essential roles during the conflict: it protected the supply lanes connecting South Africa to Britain and the rest of the empire along which troops and material moved, and it guaranteed the inviolability of the British islands while a sizeable share of the British Army was overseas. Such a display of the advantages of sea power seemed to fully justify Mahan's theories of the role of maritime power in history, especially in the light of the fact that Britain fought the war in complete diplomatic isolation.[4]

The fleets' expansion, however, was qualitative as well as quantitative. Even though warship design did not markedly change until the mid-1900s, new vessels were now built exploiting all the technical innovations delineated in chapter III. For instance, Krupp plates, combining lightness with resistance, started to be used to protect ships, such as cruisers, which, in the previous decades had usually be scantly protected, driving up costs. At the same time, better armour meant that offensive power had to increase. As a result, warships, especially battleships, started to mount more and larger guns. Starting from 1901, the Royal Navy began mounting in all its battleships, in addition to the main 12 in. guns and the quick-firing 4.7 or 6 in. guns, intermediate batteries of 9.2 in. guns.

These improvements resulted in higher costs for individual vessels, as it is evident comparing the British construction budgets for the years from 1889-90 to 1896-97 (the period of the Naval Defence Act and the Spencer Programme) with those of the period between 1897-98 and 1904-05. In the first period Britain launched 25 battleships, in the second 27. Though a similar number of vessel was launched, the funds appropriated for their construction increased from 16,8 million to 26.9 million pound, an expansion of 76%. Figure 6.2 shows data on the cost per ton of the major British battleships started in the decade 1895-1905, the upward trend is evident.

Three factors combined to favour a temporary reduction of naval expenditure in the years 1905-1908. The first was a change in international relations. In 1904 Britain reached a general agreement with France, the “Entente cordiale”. At the same time, Russian naval power was crushed by Japan, which had been ally with Britain since 1902, during the Russo-Japanese War.[5] By 1905,

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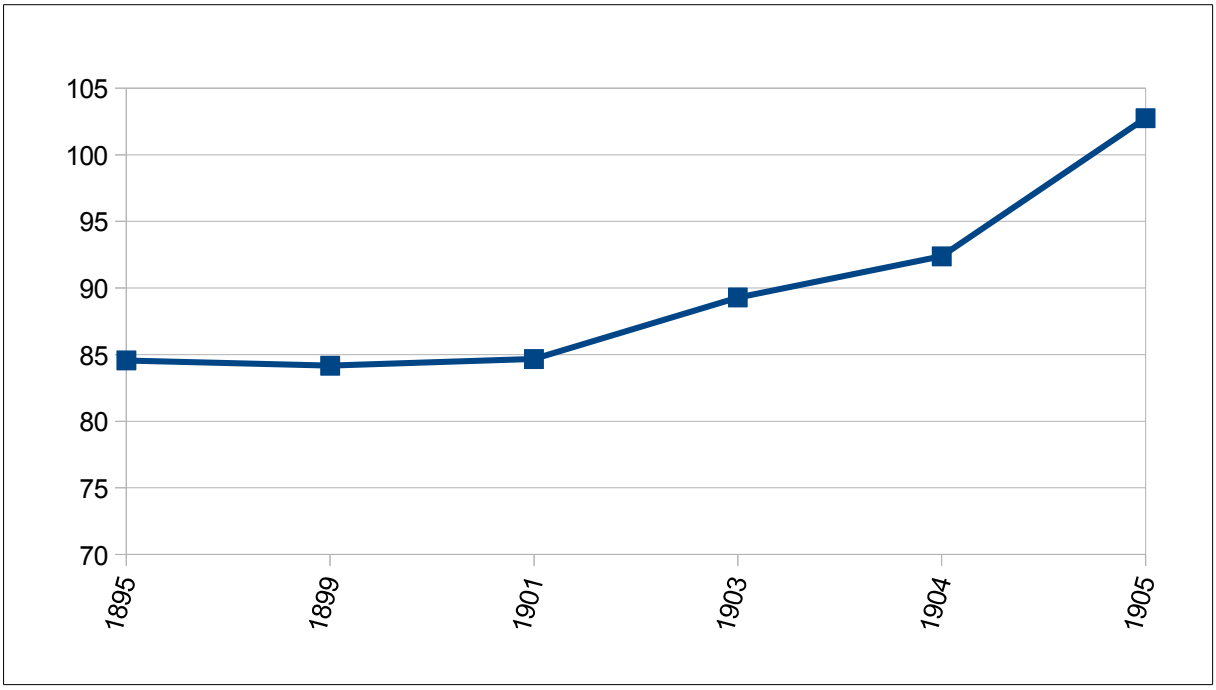
3 J. T. Sumida, *In Defence of Naval Supremacy: Finance, Technology, and British Naval Policy, 1889-1914* ((Boston, 1989), 19-21.

4 A. J. P. Taylor, *The Struggle for Mastery in Europe, 1848-1914* (Oxford, 1954), 387-392.

5 D. Woodward, *The Russians at Sea* (London, 1965), 122-159; Watts, *Russian Navy*, 20-32; D. C. Evans and M. R. Peattie, *Kaigun: Strategy, Tactics and Technology in the Imperial Japanese Navy, 1887-1941* (Annapolis, 1997), 99-137.

Figure 6.2: Cost per tons (including armaments and armour plates) of major British battleships, 1895-1905 (in real pound).



Source: calculations based on O. Parkes, *British Battleships from "Warrior" to "Vanguard". A History of Design, Construction and Armaments* (London, 1957), *passim*. Costs deflated using the website http://www.measuringworth.com/.

Britain enjoyed a clear naval superiority over all other powers. The Royal Navy was larger than the combined fleets of the Triple Alliance: it could count on 64 battleships, while France fielded 33, Germany 29, the United States 26, Italy 18, Austria-Hungary 12, Japan 13 and Russia had only 10 left.[6] Paul Kennedy is right to point that, notwithstanding the Royal Navy's impressive numbers, at the early of the 20th century British naval power was already in a phase of relative decline: Britain was facing too many commitments, while Germany and the United States had the industrial infrastructure and financial resources to challenge and potentially overcome its naval supremacy.[7] It is also true, however, that in mid-1900s the Royal Navy enjoyed a level of superiority, at least in the short term, unmatched since the time of Trafalgar.

British internal politics was a second factor. The growth of naval expenditures had started to put strains on the government's budget and, since the late 1890s, the fiscal sustainability of naval spending started to be questioned.[8] The Boer War made things worse, costing around 200 million

6 L. Sondhaus, L., *Naval Warfare, 1815-1914* (London, 2001), 191.
7 P. Kenndy, *The Rise and Fall of British Naval Mastery* (London, 1976), 206-215.
8 Sumida, *Defence*, 22-38; M. Daunton, '"The Greatest and Richest Sacrifice Ever Made on the Altar of Militarism":

pounds, more than ten times the amount initially forecast.[9] In 1901 the Chancellor of Exchequer Michael Hicks-Beach warned that the seemingly endless increase in naval spending would lead the country "straight to financial ruin".[10] Spending containment, then, became an important political issue and naval spending was not left untouched. For instance, between 1905 and 1906, the Admiralty axed more than 8,000 arsenal jobs, reducing their total workforce to around 25,000.[11]. Further reductions occurred after the 1906 election, which the Liberal Party won campaigning on a manifesto which stressed the need for social reforms, which to be financed required cuts in other parts of the government's budget.

A third factor allowing a reduction of naval spending was the reorganisation of the Admiralty and the Royal Navy carried out by John Fisher after he was nominated First Sea Lord in 1904.[12] Fisher was nominated with the brief of increasing the fleet's efficiency while, at the same time, cutting its expenditure. To do that he adopted a series of far-reaching policies: nearly one hundred obsolete vessels were scrapped, and tens of others were put in reserve. The fleet was redistributed, reducing the number of warships stationed abroad. Training, strategy, tactics, gunnery, were equally reformed. Finally, Fisher favoured the introduction of new kinds of warships, dreadnoughts and battlecruisers, with the aim of reducing costs by employing few, but qualitative superior vessels.[13]

Reduction in naval spending, however, did not last long: naval estimates for the year 1908-09 were already on the rise, a trend which lasted until the outbreak of the Great War. The reason behind this was the naval race which Germany engaged with Britain.[14] Germany had already started to modernise its fleet in the 1890s, but it adopted a much more aggressive, and markedly anti-British, policy after Admiral Alfred Von Tirpitz became state secretary for the navy in 1897.[15] Starting in 1898, Tirpitz shepherded through the Reichstag a series of naval laws financing a conspicuous enlargement of the fleet based on the automatic replacement of vessels after a fixed

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the Finance of Naval Expansion, c. 1890-1914', R. J. Blyth, A. Lambert and J. Rüger (eds.), *The Dreadnought and the Edwardian Age* (Farnham, 2011), 31-49.

9 G. Searle, '"National Efficiency" and the "Lessons" of the War', D. Omissi and A. S. Thompson, *The Impact of the South African War* (Basingstoke, 2002), 204.

10 Sumida, *Defence*, 23.

11 J. Hass, *A Management Odyssey: the Royal Dockyards, 1714-1914* (London, 1994),184.

12 E. J. Grove, *The Royal Navy since 1815* (New York, 2005), 89-92. R. F. MacKay, *Fisher of Kilverstone* (Oxford, 1973) is the standard biography.

13 P. G. Halpern, "Fisher, Sir John", *ODNB*.

14 For the diplomatic background T. G. Otte, "Grey Ambassador: The *Dreadnought* and British Foreign Policy", Blyth, Lambert and Rüger, *Dreadnought*, 51-78.

15 L. Sondhaus, *Preparing for Weltpolitik: German Sea Power before the Tirpitz Era* (Annapolis, 1997), 220-225.

amount of years of service.[16] Using this provision, Tirpitz was able to replace obsolete vessels with modern, and much larger, battleships. German's construction plans were a source of much concern in Britain, especially when Germany followed Britain in building dreadnoughts and battlecruisers. Given that dreadnoughts represented a clear break in naval technology, dividing capital ships between "dreadnoughts" and "pre-dreadnoughts", their numbers rapidly became the yardstick used to measure the relative strengths of fleets. In 1909 a war scare generated by the wrong assumption that Germany was raising the tempo of its naval construction, accelerated the process of naval expansion. Whereas in 1908-09 Britain laid down only two capital ships, the 1909-10 estimates provided for the construction of six battleships and two battlecruisers, all of them to be started before April 1910.[17] In the following two years, naval estimates financed the construction of five dreadnoughts a year. Because of the automatic replacement mechanism of the naval laws, Germany kept building battleships despite Tirpitz's hope, that Britain would not have been willing to build enough warships to preserve its lead over Germany, proved totally wrong (by 1914 Britain had forty-two new capital ships in service or under construction, versus Germany's twenty-six). Only in 1913, when the German navy was consuming near a third of the country's entire defence budget, did the German government reduce naval spending in favour of the army.[18]

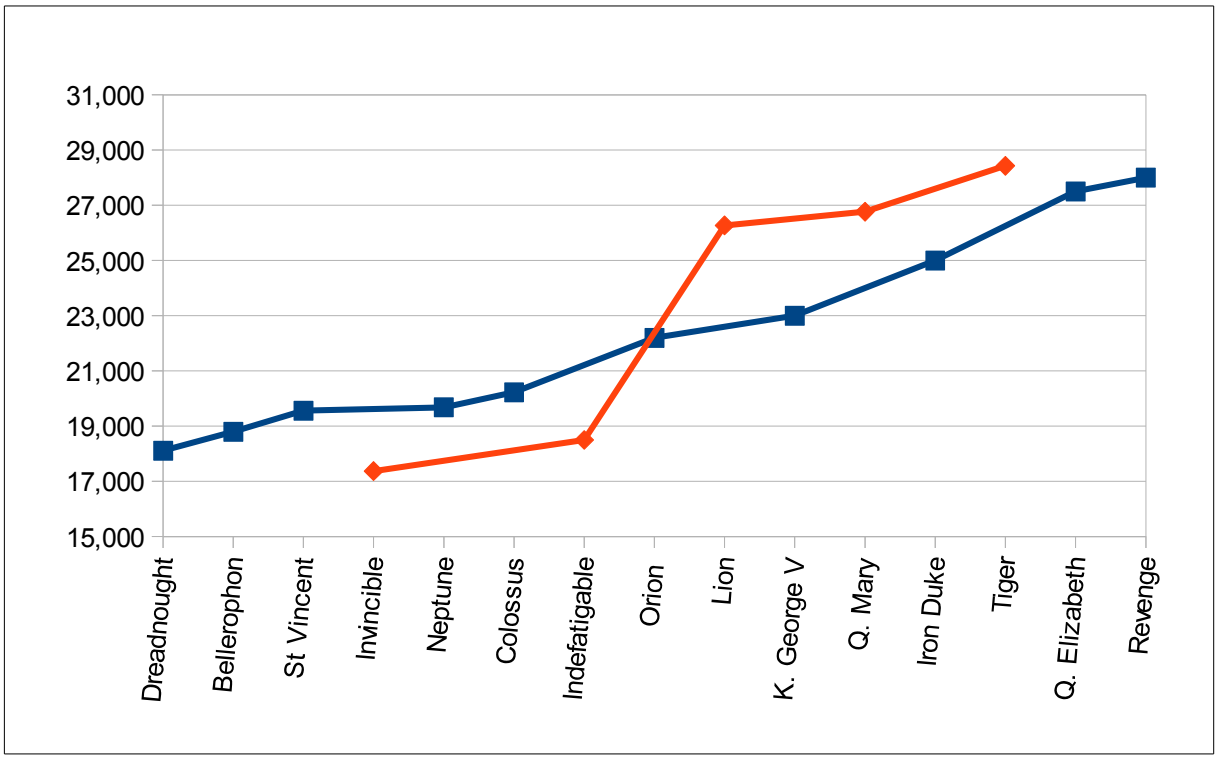
Finally, naval expenditure was driven up by the soaring costs of warships, which resulted from growing dimensions, more powerful guns and thicker armour plates. Figure 6.3 shows data on the displacement of battleships and battlecruiser from 1905 to 1914. For instance, in the nine years between which passed between the laying down of HMS *Dreadnought* and of MS *Revenge*, average capital ship displacement increased of 54,6%. Such a growth had an impact on the cost of vessels: according to the cost data in the Naval Estimates, HMS *Dreadnought* cost £1,785,000; HMS *King George V*, which was laid down in 1911, £1,961,000, and HMS *Queen Elizabeth*, which was started in 1913, around £2,500,000. It is useful to repeat here the exercise done in chapter III, and look at the trends of key components of British naval spending in the period 1897-1914. Figure 6.4 shows the trend of the three major entries: expenditures for shipbuilding carried out in government-owned dockyards, amount of contracts with private yards for the construction of warships, and spending on naval armaments.

16 J. Steinberg, *Yesterday's Deterrent: Tirpitz and the Birth of the German Battle Fleet* (New York, 1965), 124-130.

17 M. Seligmann, 'Intelligence Information and the 1909 Naval Scare: the Secret Foundations of a Public Panic', *War in History* 17 (2010), 37-59; E. L. Woodward, *Great Britain and the German Navy, 1898-1912* (London, 1964), 203-218.

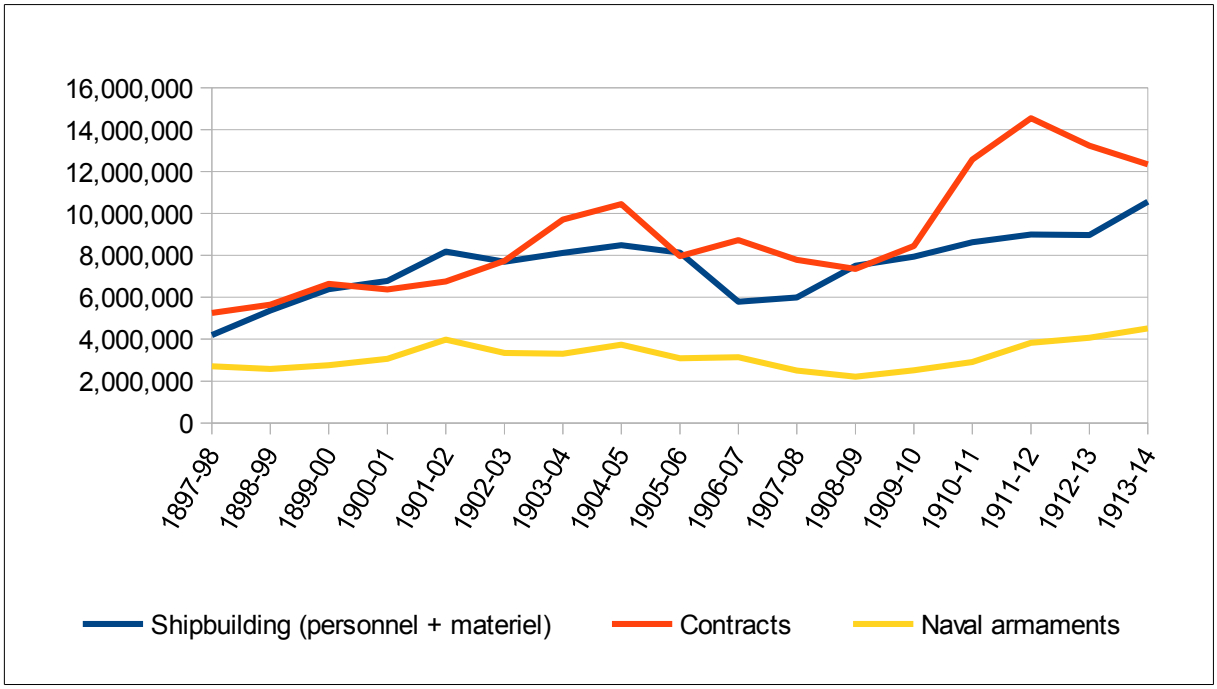
18 D. G. Herrmann, *The Arming of Europe and the Making of the First World War* (Princeton, 1996), 190; D. Stevenson, *Armaments and the Coming of War. Europe, 1904-1914* (Oxford, 1996), 289-291.

Figure 6.3: Displacements of British dreadnoughts (blue line) and battlecruisers (red line) laid down from 1905 to 1914.



Source: *Conway's All the World Fighting Ships, 1906-1921* (London, 1985), *passim*.

Figure 6.4: Trends of key components of British naval spending, 1897-1914 (in current pounds).



Source: *Navy Estimates*, HCPP, various years.

Between 1897 and the early 1900s all three entries grew. From 1902 to 1905, the value of private contracts increased, while dockyards' activities remained flat: dockyards were working at the maximum of their capacities; by contrast, private supply was more flexible because the number of shipbuilding firms which could potentially undertake warship construction was significantly larger than that of the arsenals – by mid 1900s, in Britain there were more than thirty large shipbuilders.[19] Thus, in case of necessity, to rapidly escalate production orders could be awarded to them. Starting from 1905, all three components declined as a result of the reduction in naval appropriations. The total amount of shipbuilding expenditures, contracts and naval armaments fell from more than 22 million pound in 1904-05, to little more than 16 million in 1907-08, a reduction of quite 30%.

Starting from 1908-09, naval expenditures returned to growth. The expansion of the budget translated to a large extent into a marked increase in the amount of resources devoted to buy from private suppliers. The need to rapidly counterbalance Tirpitz's plan led the Admiralty to rely to a significant extent on private shipbuilders. For example, of the eight capital ships laid down in 1909-10, six were built from private yards, and just two by the Royal Dockyards. At the same time, the need to equip more vessels led to additional resources being appropriated for naval armaments which, as it was already underlined in chapter III, were now predominantly supplied by a few private companies. Of the 42 dreadnoughts and battlecruisers begun before the outbreak of the First World War, 17 were built by the Royal Dockyards (40,5%), whereas 25 (59,5%) were built by private shipbuilders, a higher proportion than that for pre-dreadnought battleships. In general, between 1897 and 1914, a total of £127,500,000 was spent on shipbuilding carried on at the Royal Dockyards, while £151,500,000 were spent on contracts with private companies. Naval armaments totalled around £60,000,000. There is no doubt, therefore, that in those years private firms strengthened their position as suppliers of the Royal Navy. Royal Dockyards still built a sizeable number of vessels, but the private sector played now an essential role, both by satisfying part of the "routine" demand for new construction, and by being able to rapidly expand its output in case of need.

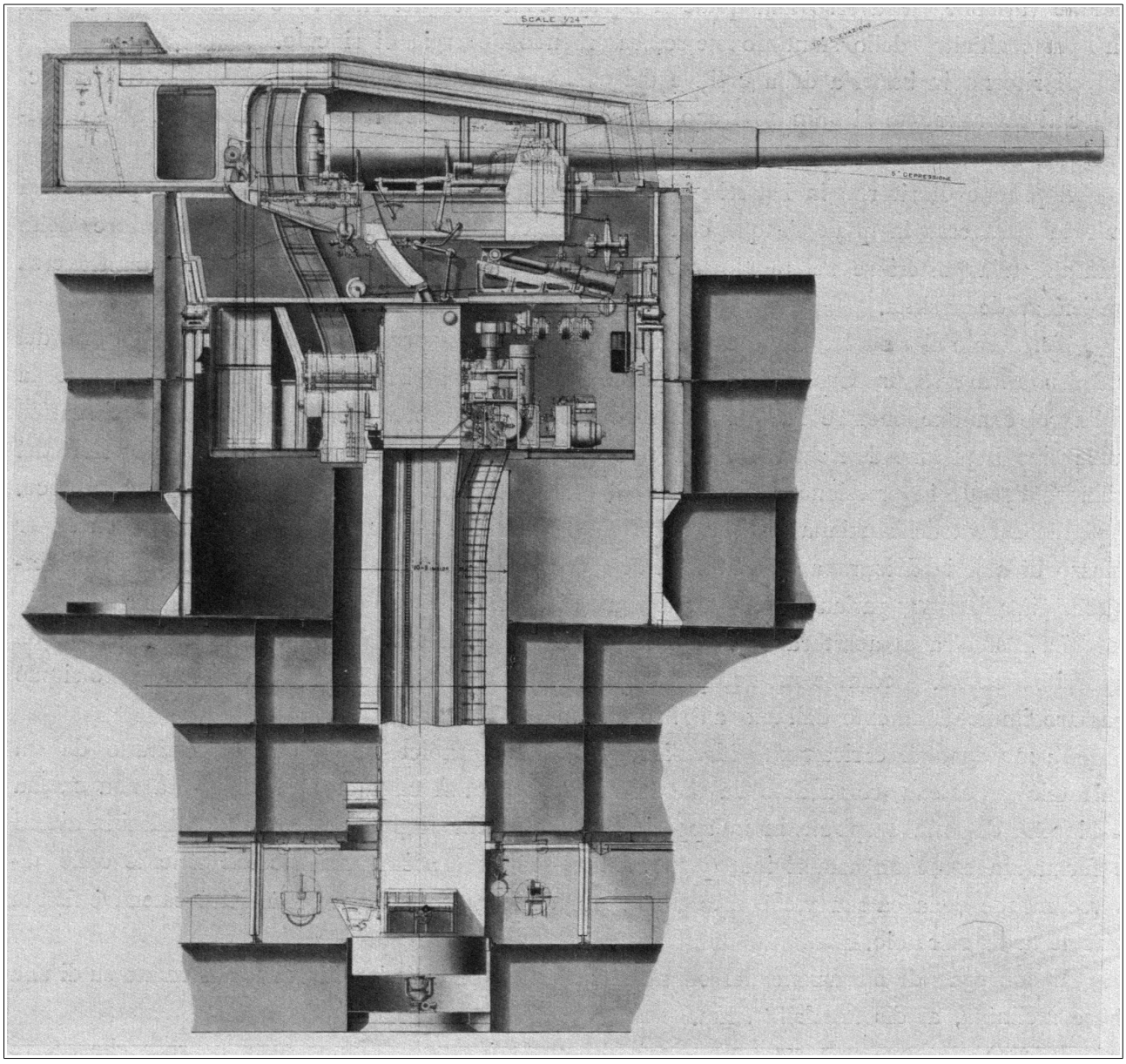
6.2 *Technological evolution.*

In terms of evolution of technology, the years from the late 1890s to the First World War can

19 Hass, *Odyssey*, 176.

be divided into two periods. The first one lasted until the introduction of dreadnoughts and battlecruisers in mid-1900s, the second from that moment until 1914.

Figure 6.5: Drawing of a 305 mm gun, and its hydraulic gun mounting produced by Armstrong.



Source: *Lo Stabilimento Armstrong di Pozzuoli dal 1896 al 1911* (Bergamo, 1911), 102.

In the first period, the basic design of vessels remained unchanged but every class of warships tended to grow in displacement: every improvement in ordnance pushed for the adoption of thicker armour plates, and vice versa; in addition, to achieve higher speed, displacement was increased to make room for larger engines and additional boilers. By 1905 battleships displaced on

average 14-15,000 tons, first class cruisers up to 14,000 tons and second class cruisers 5-6,000 tons. Battleships were still equipped with a mixed armament, made up of four 12 in. guns mounted in two twin turrets, plus a larger number of medium calibre guns (7.6, 8, 9.2 in.) and lighter QF anti-torpedo artillery.

The various components of warships went through a process of incremental evolution, based on the innovations which had been developed in the previous decade. In ordnance, for example, 12 in. guns remained the main armaments of virtually all the navies in the world (only German vessels mounted slightly smaller 11.1 in. guns). The average barrel length, however, increased markedly, from 35.4 calibres in 1895 to 45 calibres in 1905. A longer barrel meant a higher muzzle velocity, which offered more penetration power, but had the side effect to complicate production. At the same time, improvements in the hydraulic system of gun mountings increased the rate of fire by significantly cutting the time required to return a gun in position notwithstanding the growing weight of guns and turrets. If in 1895, a 12. in gun crew could fire a salvo every 72 seconds, in 1905 it required just 30 seconds.[20]

The introduction of HMS *Dreadnought* in 1905 radically altered naval technology.[21] Two features characterised the new vessel: the all big guns armament and the use of turbines (Figure 6.6). Since the early 1900s the idea of a vessel armed exclusively by large guns had been advanced by, among other, by the Italian naval architect Vittorio Cuniberti and Andrew Noble of Armstrong.[22] Uniform calibres simplified firing because it was easier to adjust the targeting of a single salvo of same calibre guns, rather than the multiple splashes of mixed armaments. The Russo-Japanese War, the first conflict involving modern fleets after 1866, provided some additional lessons on gunnery. The predominant opinion among naval experts was that long-range artillery duels occurring at more than 6-8 kilometres of distance would become the main way to engage the enemy in the future.[23]

HMS *Dreadnought* was laid down in Portsmouth Dockyard in 1905, on the base of a design produced by a special committee inside the Admiralty working under the auspices of Fisher. Thanks to generous premiums and ample use of overtime hours, the vessel was commissioned less than a year later, an unprecedented feat which was never replicated for any other dreadnought vessel. HMS *Dreadnought* was armed with 10 12 in. guns in five twin turrets, making it the most heavily

20 J. Campbell, 'Naval Armaments and Armour', R. Gardiner (ed.), *Steam, Steel and Shellfire: The Steam Warship 1815–1905* (London, 1992), 165.

21 For a technical and strategic assessment, J. Brooks, '*Dreadnought*: Blunder of Stroke of Genius?', *War in History* 14 (2007), 157-178.

22 J. Roberts, *The Battleship Dreadnought* (London, 1992), 8-9.

23 P. Towle, 'The Evaluation of the Experience of the Russo-Japanese War', B. Ranft, *Technical Change and British Naval Policy, 1860-1939* (Sevenoaks, 1977), 65-79.

armed vessel in service in the world. Long-range centralised fire required the development of systems capable of calculating the trajectories of projectiles. Various fire-guidance systems (basic analogue computers) were developed but this necessity was not satisfactorily revolved until the end of the First World War, and proved a source of much controversy.[24]

The vessel's propulsion system was based on four-shaft Parsons turbines. Turbines had several advantages over traditional reciprocating engines: they were lighter, smaller, simpler to maintain, and generated much less vibration. Adopting turbines, however, was a risky move because until then turbines had been used only in destroyers and in a few merchant vessels, none of them as big as a battleship. Turbines, however, were selected because they could generate higher speeds than multiple-expansion engines: in fact HMS *Dreadnought* could achieve a peak speed of 21 knots, fast enough, that is, to overcome every other warship, but also the many torpedo boats.[25] Overnight, HMS *Dreadnought* made all previous capital ships obsolete. Together with dreadnoughts, Fisher introduced the battlecruiser, a class of vessels which had the same displacement and armaments of a dreadnought battleships, but which were able to achieve 25 knots of speed thanks to a much lighter protection. Despite the fact that Fisher regarded battlecruisers as the real innovation – in fact he favoured a gradual replacement of battleships with a mix of battlecruisers, submarines and destroyers – before 1914 only Germany and Japan followed Britain in building battlecruisers; by contrast, dreadnought battleships proved much more successful.[26]

As soon as the basic design of dreadnoughts was introduced, incremental improvements started to be added. As figure 6.3 clarifies, the displacement of subsequent classes of dreadnoughts and battlecruisers increased. Because the length of the barrel of a 12 in. gun could not be more than 45 times the length of its calibre or it tended to bend, larger calibres started to be developed to increase ordnance penetration power.[27] In 1912 Vickers introduced a 13.5 in. gun, while Elswick proposed 14 in. artillery. Such a trend was not confined to Britain, but it occurred in all major navies, with every new class of dreadnoughts being larger, faster, better protected and more heavily armed than the previous one.[28]

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24 For a synthesis of the debate: J. Brooks, *Dreadnought Gunnery and the Battle of Jutland. The Question of Fire Control* (London, 2005).

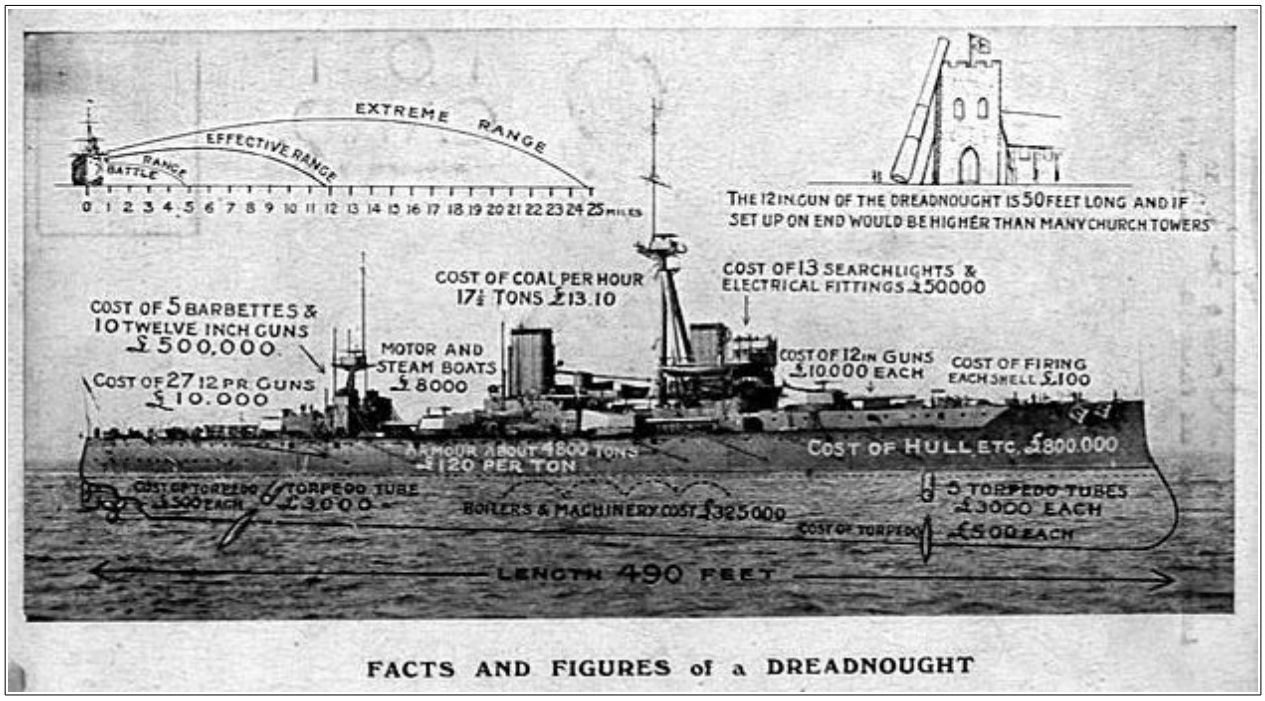
25 D. Griffiths, *Steam at Sea: Two Centuries of Steam-powered Ships* (London, 1997), 142-145.

26 J. T. Sumida, 'Sir John Fisher and the Dreadnought: The Source of Naval Mythology', *Journal of Military History* 59 (1995), 619-637; N. A. Lambert, 'Admiral Sir John Fisher and the Concept of Flotilla Defence, 1904-1909', *Journal of Military History* 59 (1995), 639-660; and id. *Sir John Fisher's Naval Revolution* (Columbia, 2002).

27 P. Hodges, *The Big Gun. Battleship Main Armament 1860-1945* (London, 1981), 61.

28 For the evolution in warship's design, N. Friedman, *Battleship Design and Development, 1905-1945* (Greenwich, 1978); D. K. Brown, *The Grand Fleet: Warship Design and Development, 1906-1922* (London, 1999).

Figure 6.6: Postcard featuring HMS *Dreadnought*'s features and cost, 1906.



Source: http://www.seayourhistory.org.uk

Another field which rapidly evolved in the decade before 1914 was submarine technology. In these years, submarines evolved from mechanical curiosities to proper instruments of war.[29] A first important innovation was the introduction of heated torpedoes. Torpedoes used compressed air as source of energy. In the early 1900s, it was discovered that if the compressed air was heated by means of some liquid fuel, torpedoes' speed increased. On the eve of the Great War, torpedoes could travel up to 4,500 meters at a speed of 30-32 knots.[30] In the 1880s the Swedish inventor Thorsten Nordenfelt had designed the first submarine armed with torpedoes. By the early 20th century, all major naval powers had started building submarines: the Royal Navy purchased its first submarines in 1901, Russia in 1902, Italy in 1903, Japan in 1904, and Germany in 1906.[31] Submarines' performance improved thanks to the adoption of the safer and more efficient diesel engines, but they still suffered from short ranges because little fuel and provisions could be stored on board. Therefore, until 1914, submarines were confined to coastal defence duties, rather than for ocean operations.

29 For a detailed history of the evolution of submarines before 1914, P. Akerman, *Encyclopedia of British Submarines, 1901-1955* (Penzanze, 2002).
30 D. Van der Vat, *Stealth at Sea: the History of Submarine* (London, 2002), 43.
31 E. W. Osborne, 'Submarine, Evolution of', S. C. Tucker (ed.), *Naval Warfare. An International Encyclopedia* (Santa Barbara, 2002), 976-978.

Despite improvements in submarines and torpedoes, the introduction of dreadnoughts reinforced the view that large battleships were the linchpin of naval warfare and an embodiment of national prestige. As Sondhaus remarks: "Like nuclear weapons in the latter decades of the twentieth century, possession of dreadnoughts meant that a country counted for something in global or regional balances of power, and the ability to build them from one's own domestic resources became the measure of true great power status."[32] By 1914, all major European powers, as well as Japan and the United States, were actively building dreadnoughts. In addition, second ranking powers were also investing large sums to acquire the most up-to-data naval technology: Spain was building its own fleet of dreadnoughts, while both Greece and Turkey had ordered battleships from yards abroad, and the three major south American countries, Brazil, Chile and Argentina, had equally contracted the construction of two dreadnoughts each to foreign companies.

6.3 *The evolution of British private armaments industry.*

In the period from 1897 to 1914, two major trends shaped the evolution of the British armaments industry. The first one was the entrance of new firms in the armaments industry. The second was the tendency of armaments companies towards creating, by mergers, acquisitions, and new investments, vertically integrated organisations able to produce the majority of, if not all, the components of a warship. The differences which existed between the British armaments industry in the late 1880s and the one of the 1900s were summarised by William White, the former Admiralty's Director of Naval Construction, in an article he wrote for *The Times* in 1906:

> Instead of two armour-plate works [John Brown and Cammell] existing in 1888, whose annual output was about 8,000 tons, Great Britain possessed in 1902 five first-class factories [John Brown, Cammell, Armstrong, Vickers and Beardmore], whose united possible annual production amounts to about 50,000 tons of armour. Messrs Armstrong were practically the only firm making heavy guns and gun-mounting in 1889; the government arsenal at Woolwich produced some heavy gun-mountings, but took no part in the work for the Naval Defence battleships. Efforts were made at once to extend source of supply for gun-mountings, and Messrs Whitworth developed this branch of manufacture. Messrs

32 Sondhaus, *Naval Warfare*, 201.

> Vickers followed, and have attained a commanding position both in gun and gun-mounting manufacture. Messrs Beardmore have since taken up similar work; and at the present time the associated firms of John Brown, Cammell Laird, and Fairfield are constructing great ordnance works at Coventry and on the Clyde. As a consequence the manufacturing capability of the country in guns and gun-mountings will be raised to as great a position as its armour-plate works reached four years ago … All this has been done by the enterprise of private firms, encouraged by the government orders no doubt, but taking the inevitable risks of fluctuations in employment and diminution or absence of returns on the enormous amount of capital invested in plant and buildings.[33]

Figure 6.7 shows a schematic representation of the major British firms active in the armaments industry in the early 1910s following the same criteria adopted for figure 3.8 in chapter III. Comparing the figures, two things are immediately evident: on average, the number of firms active in each production increased; at the same time, more firms came to be heavily dependent on armaments production.

Figure 6.7: British armaments industry in the early 1910s.

Relative importance of armaments production on each firm's business

Productions	High	Medium	Small
Ordnance	Armstrong Vickers C.O.W. Beardmore		
Armour plates	Vickers Armstrong Beardmore	John Brown Cammell Laird	
Naval shipbuilding	Armstrong Vickers Beardmore	John Brown Cammell Laird	Several shipbuilding firms

The growth of the British naval budget (it doubled in less than twenty years before 1914)

33 *The Times* 16 November 1906, 17.

proved a strong incentive for firms to venture into armaments production. The introduction of dreadnoughts and battlecruisers in 1905 generated a large demand for new construction by both the Royal Navy and foreign governments which wanted to rapidly acquire the new warships. There must be caution, however, before claiming that defence contracts necessarily offered a higher level of profitability than civil production. Shipbuilding is the only field for which it is possible to compare roughly similar civil and military productions. Different analyses, however, have not offered unanimous results: whereas More in his study of Fairfield claims that the firm's returns on military contracts were significantly higher than that over merchant shipbuilding, Arnold, in his analysis of the activities of the major naval shipbuilders, stresses that their average level of profitability was not unusually large.[34] These analyses are useful but partial. Several naval yards belonged to large armaments firms which supplied them with inputs such as armour plates and guns, whose relative prices they could manipulate, others were independent firms. In addition, accounting practices were far from being uniform, even inside the same sector. At the end of this chapter the performances of the largest armaments firms are compared using the dividends they paid as yardstick. While this is a less than perfect method, it does allow the assessment of the relative profitability of the major British armaments firms in their entirety.

The other major trend shaping British armaments industry was vertical integration. In the period from the late 1890s to the early 1900s, a series of mergers and combinations markedly increased the concentration inside the armaments sector. These were the major arrangements:

- In 1897 Vickers purchased the Naval Construction and Armaments Company in Barrow-in-Furness in 1897 for £425,000 and the Maxim Nordenfelt Company for £923,334.[35]
- The same year Armstrong merged with Whitworth, creating the Sir W. G. Armstrong Whitworth Company, with a capital of £4,000,000.
- In 1899 John Brown purchased Clydebank Engineering and Shipbuilding Company for 923,255.[36]
- In 1902 Vickers purchased 50% of the capital of Beardmore, a Scottish firm involved in armour making and naval shipbuilding, through an exchange of shares: 389,500 £1 shares of

34 C. More, 'Armaments and Profits: the Case of Fairfield', *Business History* 24 (1982), 175-186; A. J. Arnold, 'Riches beyond the dreams of avarice? Commercial Returns on British Naval Construction, 1889-1914', *Economic History Review* 54 (2002), 267-289.
35 *The Times* 17 November 1897, 4.
36 K. Warren, *Steel, Ships and Men: Cammell Laird, 1824-1993* (Liverpool, 1998), 105.

Vickers were exchanged for 750,000 £1 share of Beardmore.[37]

- The same year, John Brown acquire 7/8 of the capital of Thomas Firth & Son, a Sheffield firm manufacturing large steel forgings for guns.[38]
- In 1903 Cammell purchased the small Mullinger-Wingley ordnance factory in Coventry for around £140,000.[39] This plant was subsequently enlarged and the company renamed Coventry Ordnance Works (C.O.W.). Part of its capital was sold to John Brown.
- Later the same year Cammell merged with Laird Brothers shipbuilding company, creating Cammell Laird, with a total capital of £2,500,000.
- In 1905, Cammell Laird acquired 50% of Fairfield of Glasgow, a shipbuilding and engineering firm, which invested £187,500 in C.O.W.
- In 1907, John Brown acquired an interest in Harland & Wolff in Belfast, a yard specialised in merchant vessels and passenger liners.[40]

Several factors pushed British firms toward vertical integration. The first was the nature of technological development. Armaments production became increasingly complex because of the use of more sophisticated materials (steel alloys) and because the sizes of guns, armour plates, warships, etc. kept increasing. Only highly capitalised firms could undertake the large-scale investments required to adapt production processes to the advancing standard of military technology, increasing the size of a firm by enlarging the perimeter of its activities made easier made this easier. A second reason, was that vertical integration guaranteed a market for the various productions of a firm, and it reinforced its commercial appeal. If a company won a contract for a warship, its yard could obtain armour plates, large forgings and ship plates from the firm's steel works and guns and mounting from the ordnance works. Vertically integrated firms could then increase the rapidity of construction – because internalised exchanges reduced asymmetry of information and the length of negotiations, and because internal orders usually received priority over other contracts – and offer their customer a "full package" (i.e. an entire, fully armed, warship), an option which was especially attractive for customers rather than having to sign separate contracts with various suppliers. A third reason was the desire to internalise transaction costs.[41] Suppliers of high-quality, sophisticated products, such as artillery or armour plates, enjoyed

37 H. W. Macrosty, *The Trust Movement in the British Industry. A Study of Business Organisation* (London, 1907), 42.
38 A. Grant, *Steel and Ships. The History of John Brown's* (London, 1950), 38.
39 *History of Coventry Ordnance Works* (Coventry, 1910), 5.
40 *The Times* 29 June 1907, 7 and 15.
41 On transaction costs and vertical integration, O. E. Williamson, 'The Vertical Integration of Production: Market

a high degree of bargaining power over their customers which had, therefore, the incentive to enter into those productions to internalise the profits enjoyed by their oligopolistic suppliers (obviously, such a move needed to be weighted against the costs and difficulties of entering into a new field). A fourth reason was that, after competitors started to vertically integrate, a firm active in the same sector had little option, if it did not want to be left out in the cold, but to replicate to such moves by adopting the same strategy.

The result of this wave of integration was that, by mid 1900s, the British armaments industry was made up of firms which, to acquire economies of scale and expand their productions, had heavily invested to enlarge their perimeters. As a result, they faced large fixed costs which could be covered only by keeping their plants working constantly. The combined demand generated by the Royal Navy and by foreign customers, however, was not sufficient to achieve this, and not all British armaments firms were equally successful in the fifteen years before 1914.

The sub-sections below present a brief synthesis of the evolution of the various British armaments companies, an assessment of their foreign operations and of the level competition which existed inside the armaments industry. A comparison of the profitability of the various firms is offered in the conclusion.

Armstrong

In 1897 Armstrong merged with Whitworth. Though Whitworth had died ten years before, the firm still retained a small ordnance business which could take advantage of the growing British naval budget. Already in 1896, Armstrong's board had decided to approach Whitworth to "unofficially ascertain whether in the tenders for the 12 in. mountings of battleships an approximate uniformity of price in our mutual tender could be secured, without any obligation for the future."[42] Armstrong was keen to avoid the rise of another rival, after Vickers. Buying Whitworth, thus, would reinforce Armstrong's position and eliminate a potential competitor. This was the same tactic Armstrong had used in the past, for example, when it had purchased Vavasseur's ordnance business.

Two other reasons, however, were behind Armstrong's decision. The first was Vicker's purchase of the Barrow shipyard and of Maxim-Nordenfelt. These two acquisitions, happening one

Failure Considerations', *American Economic Review* 61 (1971), 112-23.

42 T&W, 130/1266, *Minutes*, 22 April 1896.

after the other, rapidly transformed Vickers by greatly expanding its armaments business. Armstrong feared that Vickers might also acquire Whitworth. By buying Whitworth, Armstrong could deny Vickers access to its technological know-how. As Andrew Noble wrote to Stuart Rendel: "by rescuing Whitworth we can effectively checkmate them [i.e. Vickers] as it would be years before they can obtain the machinery and experience necessary for the construction of guns and mountings. I confess it would give me also great pleasure to check moves of our friends at the Admiralty who are fostering Whitworth at our expense."[43]

An additional reason was that, by buying the Manchester-based rival, Armstrong obtained crucial components for armour making, a production which Armstrong lacked but which the firm wanted to acquire. As Lord Armstrong summarised in a letter to Stuart Rendel: "Vickers minus Whitworth is not to be feared", at the opposite, "what we gain by absorbing Whitworth is a duration of our supremacy". In addition, "the Whitworth shops [at Openshaw] are very spacious and have room for great expansion of plant. At Elswick the shops are already over-crowded. Whitworth [has] already finished the most powerful forge press in the world for making armour plates for the supply of which our expenditure is at the present enormous."[44] In January 1897 the two boards finally approved the amalgamation, creating the Sir William Armstrong Whitworth & Co. Ltd. with a capital of £4,000,000, of which three quarters came from Armstrong. The difference between the two firms at the time of the amalgamation is made even more evident by comparing their workforce: Armstrong employed around 19,000 workers, Whitworth less than 2,000.[45]

The first preoccupation of the new firm was to start armour plate production. Whitworth had taken some steps in that direction, but much still had to be done. After more than one year of careful planning, the members of the special subcommittee for armour plates created inside the board reported that they were "unanimously of the opinion that armour plate works should be erected with the least possible delay at Openshaw. They estimate the total cost of the erection of these works at from £250,000 to £300,000, of which sum an approximate expenditure of £100,000 has been already incurred … in the erection of the large 10,000 tons press and its accessories."[46] To ascertain how to best erect the works, Vavasseur toured various armour plate shops in Europe, among them the Terni plant in Italy. Erecting the armour plates mill, however, was more complex than expected:

43 T&W, 31/7595, *Rendel Papers*, 8 December 1896.
44 T&W, 31/7595, *Rendel Papers*, 22 December 1896.
45 *Financial Times* 29 December 1896, 4 and 25 January 1897, 5. Armstrong had no interest in Whitworth's machine tools business which was sold to Craven Brothers Limited of Manchester, A. E. Musson, 'Joseph Whitworth and the Growth of Mass-production Engineering', *Business History* 17 (1975), 149.
46 T&W, 130/1266, *Minutes*, 9 June 1898.

after a few months, the special armour plate committee suggested that the firm should adopt rolling rather than forging (at that time the universal practice in Sheffield and on the continent) to make chrome steel plates. The committee proposed the erection of a rolling mill capable of reducing a 60 ton ingot into a 40 ton plates in 40-50 minutes. The final cost of the armour plate plant was reckoned to have now increased to £450,000,[47] an evaluation which the board revised upward to £490,000.[48]

The expanding British naval budget resulted in large profits for Armstrong. In 1897, for example, "Sir Andrew Noble remarked [during a meeting of the board] that the year now ending has proved the most favourable in the history of the Company. The total of orders for the ordnance works had been reached which amounted for the year approximately to five and a half millions." The Second Boer War provided additional substantial orders, especially for shells, fuzes, sights, etc. For some goods, production increased by more than 75% over that of the previous year.[49] At the same time, however, high demand and endless technical evolution forced the firm to carry on a constant stream of investments. In 1901, for instance, Armstrong spent £737,583 – up to £283,304 the previous year – in capital investment and new machinery to replace the worn-out old ones.

Investment remained at a very high level to keep pace with the evolution of armaments technology: for instance, in 1905, new lathes had to be purchased because the old ones "were not long enough to take the large calibre guns."[50] In 1912, the board decided to invest between £220,000 and £250,000 to modernise Openshaw. Starting from 1910 the firm recognised the need to replace Elswick yard with a larger one. The growing displacement of warships required additional space, and Elswick could not accommodate ships longer than 650 ft. This put the firm at disadvantage in comparison with Vickers, John Brown or Beardmore. In 1910 the board estimated the cost of the new yard planned at New Walker, a location east of Newcastle, at no less than £500,000.[51] Within eighteen months, the price was revised upward to £820,000. Despite its staggering price, the new yard was essential for Armstrong to retain its ability to supply the Royal Navy and foreign governments with the largest warships, as Noble explained during the shareholders' meeting of 1912.[52] In 1913 the keel of the of the super-dreadnought HMS *Malaya*, the first vessel built at the new yard, was laid down.

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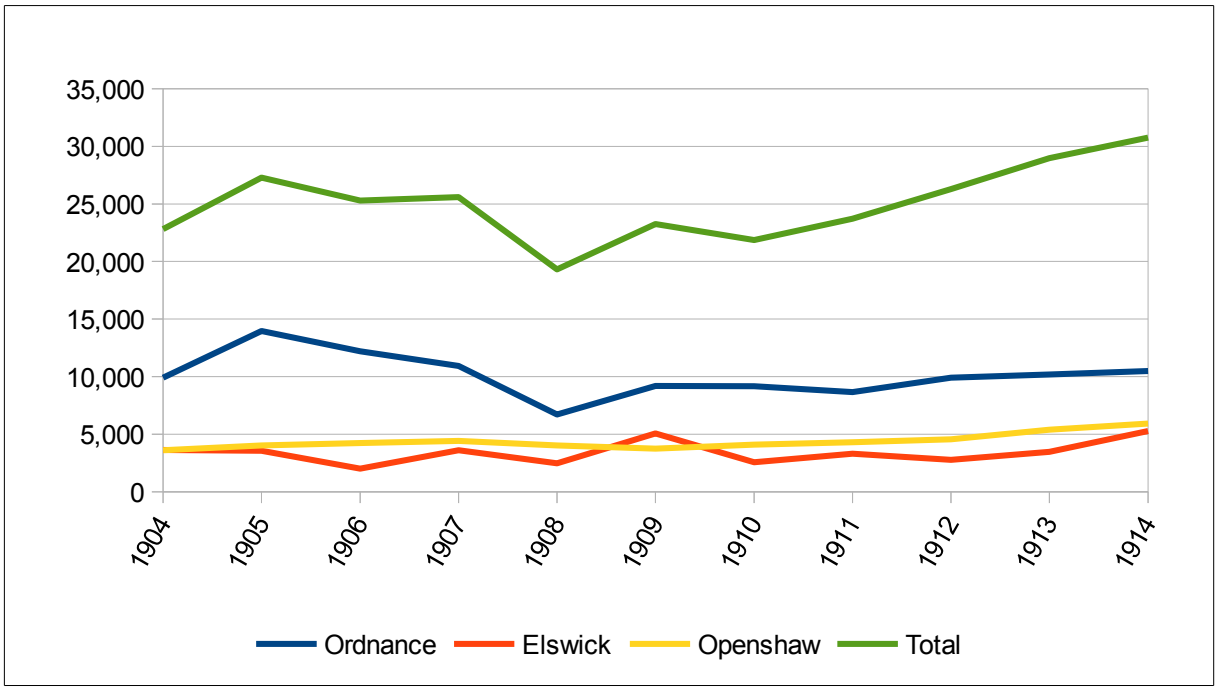
47 T&W, 130/1280, *Minutes of the armour plate committee*, 20 March 1899.
48 T&W, 130/1266, *Minutes*, 21 March 1899.
49 Id. 18 September 1899.
50 *The Times* 30 September 1905, 6.
51 T&W, 130/1267, 17 February 1910.
52 *The Financial Times* 19 April 1912, 5.

Starting from the 1890s the domestic market grew more and more crucial for Armstrong. Foreign orders remained important, but, as it will be explained below, Armstrong and the other British armaments firms increasingly moved from being sellers of armaments to becoming partners in local joint-ventures. The impact of British orders can be gauged by looking at the firm's workforce. Figure 6.8 shows the number of employees in various divisions of the firm from 1904 to 1914. In the years from 1905 to 1908, that is the period during which British naval appropriations were cut, the firm axed more than 8,000 jobs. The ordnance plant and Elswick yard were hit especially hard. At the opposite, armour plates production remained more stable. Starting from 1908 onwards, the trend reverted but the workforce of the ordnance plant never returned to its 1905 level.

Figure 6.8: Number of workers employed by Armstrong in various productions, 1904-1914.



Source: T&W, 130/1266, 130/1267 and 130/1268. Total employment is calculated adding also the workforce of the units of the firm (engine works, Low Walker yard, steelworks, and Pozzuoli) which are not reported here.

Vickers and Beardmore

By the mid-1890s Vickers was an important producer of armour plates, guns and gun mountings. In comparison with Armstrong, however, it lacked shipbuilding capabilities, something

which put Vickers at a disadvantage in the export markets. In the years 1896-97 Vickers moved, thanks to its bold acquisitions of the Barrow shipyard and Maxim-Nordenfeldt, from being a civil company with an interest in the armaments business to being an armaments company with also a civil business. The timing of these purchases was especially fortunate because the Second Boer War generated a large demand for the small artillery and machines guns which Maxin-Nordenfeldt produced. The war caused, in the world of Clive Trebilcock, "an unparalleled commitment of industrial resources."[53] According to what Colonel Dawson – a Vickers's director – stated in front of the *Royal Commission on the War in South Africa*, between 1898 and 1903 Vickers invested 2 million pound in new productive capacity and improvements, or more than £300,000 a year.[54] Until 1899 Vickers had produced no field artillery, and it suddenly received orders for hundred of pieces.[55]

With end of the war, domestic demand contracted, as Albert Vickers stressed in 1909 when speaking at the shareholders' meeting: "the Company's finance has been seriously inconvenienced by the lean years which commenced with the cessation of demand at the conclusion of the Transvaal War".[56] At the same time, the firm suffered from a lull in the order of warships from the Royal Navy. Data presented below in figure 6.9 highlights how the fall in naval shipbuilding, which the Admiralty concentrated in its yards, did not result in a fall in orders for gun mountings which only private firms could supply. From 1910 onwards domestic orders returned to represent the largest share of naval shipbuilding occurring in Barrow.

Figure 6.9: Percentage of Barrow's work in hand represented by British orders, 1903-1910.

Year	**1903**	**1904**	**1905**	**1906**	**1907**	**1908**	**1909**	**1910**
% warships	100.0	76.3	50.1	31.1	27.7	41.8	28.5	89.9
% mountings	100.0	92.2	53.1	80.2	77.3	96.5	92.9	71.3

Source: VA 1116, VA 589, 1104.

The fall in domestic orders was compensated, at least partially, by orders from abroad:

53 C. Trebilcock, 'War and the failure of industrial mobilisation', J. M. Winter, *War and Economic Development. Essays in memory of David Joslin* (Cambridge, 1975), 141.
54 *Royal Commission on the War in South Africa*, HCPP, q. 20945.
55 Id., qq. 20908-20914.
56 *Arms and Explosives*, April 1909.

between 1903 and 1910 Barrow built warships for foreign customers worth a total of £5,135,037.[57] This fact demonstrated the success of the firm's strategy of vertical integration: Vickers was now able to compete with Armstrong in selling battleships and cruisers to foreign customers because it was in the position to offer to supply an entire warship, from the hull to the guns. That Vickers sold various vessels to Japan testifies to the fact that the firm had been able to match Armstrong in its ability to offer an attractive "package" to foreign customers.

In 1902 Vickers purchased 50% of the shares of Beardmore, a Scottish steel firm based near Glasgow. Since the 1870s, Beardmore's major business was supplying ship plates and large forgings to the Clyde shipbuilding industry. In the late 1890s, attracted by the potential returns, Beardmore started to implement an ambitious plan for the development of armour and gun-making capabilities. For example, in 1896 the firm purchased a 12,000 tons press, the largest in the world to start the production of armour plates. Beardmore's management, however, had still more ambitious plans and it purchased the old yard of Robert Napier with the aim of entering into naval shipbuilding. Because Napier's yard was not large enough to accommodate battleship construction, Beardmore started the construction of a much larger yard in Dalmuir. The firm's breakneck expansion did not result, however, in large orders.[58] Even though the British demand for armour plates and guns was growing, it was not expanding rapidly enough to accommodate the new large capacity created by Beardmore. In addition, the Admiralty was certainly cautious in offering large contracts to a firm which, regardless of the prices it might quote, was a new entrant, with a very limited experience in such complex productions as armour plates and guns. By 1901 Beardmore had run out of credit. Vickers intervened and purchased half of the company for £750,000.

The Economist commented that "the financial advantage to either company of the projected co-partnership is not obvious".[59] In fact the two firms manufactured to a large extent similar products. The reason behind Vickers's move, however, were strategic rather than economic. By acquiring this interest, Vickers was able to check the rise of a potential rival in the armaments business. Given that the armaments market in Britain in 1902 was suffering from the end of the boom generated by the Second Boer War, limiting competition was crucial. Associating the firm's name to Vickers was, for Beardmore, a way to improve its image and attract more orders. The link with Beardmore proved expensive for Vickers, though: the Scottish firm was unable to secure many contracts until the 1910s, and Vickers's representatives often clashed with the rest of the board

57 VA 589, *Barrow Works Foreign Warships Built (1900-1930)*.
58 J. R. Hume and M. S. Moss, *Beardmore. The History of a Scottish Industrial Giant* (London, 1979), 51.
59 *The Economist*, 25 January 1902, 114-115.

trying to limiting expenditure and investments: between 1902 and 1909 Beardmore invested around 2,8 million pound to enlarge its armour making plant and yard, while, at the same time, it paid very small dividends.[60] In 1910 Vickers tried to convince Armstrong to acquire an interest in Beardmore, but Armstrong's management declined the offer.[61]

Vickers demonstrated its foresight when it decided to enter into submarine production in the early 1900s. No British firm had ever undertaken such a production before, and, initially, there was plenty of scepticism about the real value of submarines in warfare. *The Engineer* stated that there was no doubt that "they can never be a serious danger to ships in rapid movement".[62] The arrival of Fisher to the Admiralty, however, signalled a change in mentality and submarines started to be regarded as capable of playing a significant role in naval warfare, at least in coastal defence. Vickers recognised that the best course of action to rapidly enter into the field was to acquire the expertise it needed from an established producer: it thus signed an agreement with the American Electric Boat Company – producer of the Holland submarines – which granted Vickers the exclusive right to use its patents and design in Britain.[63] Vickers then proceeded to sign a contract with the Admiralty in 1904 which gave the firm the virtual monopoly of the production of all the submarines of the Royal Navy, a monopoly which lasted until 1911. Whereas submarines were much cheaper than battleships – they cost around £41,000 each[64] – they offered a return on costs of near 50% and required little additional investment. Trebilcock calculated that submarine construction produced a total profit for Vickers of £1,250,000 between 1902 and 1914.[65]

Finally, Vickers and Armstrong teamed up in 1906 to acquire for £200,000 each a dominant interest in the Whiteheat Torpedo company which had been put up for sale.[66] With such an acquisition both firms nearly completed the range of naval armaments they could produce.

John Brown, Cammell Laird and the Coventry Ordnance Works

John Brown and Cammell followed the steps of Armstrong and Vickers in pursuing a policy

60 T&W *Rendel Papers* 31/6489, *Memorandum of the Financial Affairs of William Beardmore & Co, for the Directors of Armstrong Whitworth & Co.*, 29 July 1910.
61 T&W 130/1267, *Minutes*, 5 May, 4 August and 6 October 1910.
62 *The Engineer*, 9 Mach 1901, 5.
63 Scott, *Vickers*, 63-65.
64 VA 739, *Submarines, Costs and Quotation (1903-1906)* and VA 740, *Submarines built at Barrow* (1902-1947).
65 C. Trebilcock, *The Vickers Brothers. Armaments and Enterprise, 1854-1914* (London, 1977), 107.
66 T&W, 130/1267, *Minutes*, 17 May 1906.

of vertical integration by acquiring the control of shipbuilding companies. In 1898 John Brown purchased Clydebank, one of the major yards on the Clyde which had already built warships for the Royal Navy. In 1903 Cammell merged with the Laird Brothers yard in Birkenhead. Laird Brothers' yard had expanded significantly in the 1890s thanks to orders coming from the Royal Navy. In that decade, 62,4% of its output was made up of warships (up to 9.7% in the 1880s).[67] Between 1892 and 1901 the yard launched four major battleships. The wave of mergers of the late 1890s, however, risked leaving Laird out in the cold, without links to any major supplier of armour plates and steel forgings. At the same time, in the early 1900s Cammell was the only armaments firm which did not own a yard which could absorb its production. The merger between the two firms was thus something natural because the two activities – armour making and naval shipbuilding – "might advantageously be worked in conjunction", as stated by Laird's management.[68] The new concern had a capital of £2,500,000 the majority of which came from Cammell (£1,750,000). The merger between Laird and Cammell, however, proved less successful than that between John Brown and Clydebank. A first problem was that between 1902 and 1911, Laird's share of naval construction felt behind that of all the other major armaments group, as shown in figure 6.9.

Figure 6.9: Major naval constructors, 1902-1911

Company	**Total tonnage**
Vickers	112,185
Armstrong	104,350
John Brown	82,550
Fairfield	71,050
Palmer	50,500
Thames Ironworks	41,550
Beardmore	37,150
London & Glasgow	30,450
Scott	20,000
Cammell Laird	14,000

Source: HCPP, *Naval Estimates*, various years.

67 Calculations based on the List of Laird launchings Warren, *Steel,* 95-99.
68 *Financial Times* 24 September 1903, 3.

In addition to the fact that the merger occurred exactly before British naval expenditures were cut, Laird's yard was too small and inefficient to compete with the larger and more modern yards owned by other armaments firms. To partially solve the problem, in 1905 Cammell Laird purchased 50% of Fairfield, another Clyde-based shipbuilder and engine makers which was markedly more successful than Laird in gaining orders from the Admiralty, although it still built less than its major competitors.[69]

Cammell Laird, however, went through still more serious problems in the years 1906-08. In late 1906, the chief inspector of Woolwich advanced doubts about the quality of some of the firm's products, especially its armour plates. The first preoccupation of the War Office and Admiralty was the quality of the products, thus in 1907 they removed Cammell Laird from the list of their contractors.[70] This was a serious problem because, as Elgar, the firm's chairman, stressed in the letter he sent to the Admiralty a year later to ask for Cammell Laird to be reintegrated in the list, if the Company was not trusted by its own government, it had not hope of securing any foreign contracts.[71] The firm regained its position only after a reshuffle of its management, and a reorganisation of the works which guaranteed a better control of the final quality of its productions.

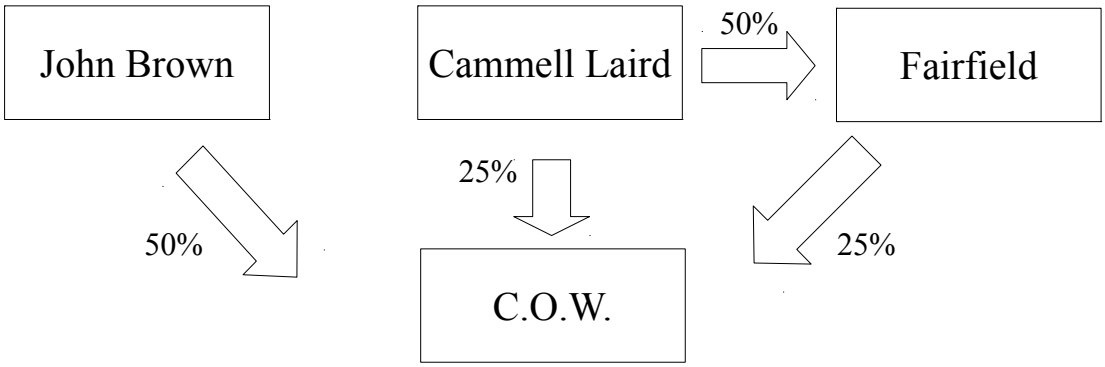
The major constraint John Brown and Cammell suffered from was the absence of any autonomous gun and gun mountings capability. Whereas armour making remained a profitable trade, the number of firms active in that field in the 1900s was larger than it was ten or twenty years before, when the two Sheffield firms completely dominated the market. At the same time, competition in naval shipbuilding was still fiercer, because the number of firms which could make warships was large. At the opposite, gun making was a field still exclusively controlled by just two firms which, because of this, dominated both exports and domestic supply. In 1902 Cammell bought Mullinger-Wingley, a small firm in Coventry which manufactured components for artillery. In 1905 this small firm was transformed into the Coventry Ordnance Works after Cammell sold half of its share to John Brown, and another 25% to Fairfield (Figure 6.11). The shareholders started to pump money into C.O.W. to transform it from a small producer of ordnance component into a serious competitor for the more established producers in all kinds of artillery.

Armstrong and Vickers joined forces to damage the new entrant, whose presence was especially worrisome at a time when the British naval budget was being cut. They adopted a two-pronged strategy. On the one hand they used their market power to limit C.O.W.'s market share. As

69 Id., 23 November 1905, 5.
70 *The Financial Times* 9 November 1907, 5, and 8 April 1909, 8.
71 Warren, *Steel*, 131.

a War Office report in 1910 stated there was a suspicion that C.O.W.'s competitors "had quoted cutting rates in order to stifle the development of competition for gunwork which Coventry had taken up for the first time in connection with the rearmament of the field artillery."[72] Though the government could have been in favour of enlarging the number of suppliers, it could hardly justify awarding contracts to a company which systematically offered higher prices. On the other hand, Armstrong and Vickers lobbied hard to prevent the designs of weapons they had previously submitted to the Admiralty and War Office to be passed to C.O.W. As Noble wrote to the Admiralty, "That we should receive royalties upon certain patented details is quite inadequate compensation for the injury done to us by continuing to raise up at our expense rivals who, without either expenditure or experience, are enable to compete with us, not only in England but in foreign countries."[73]

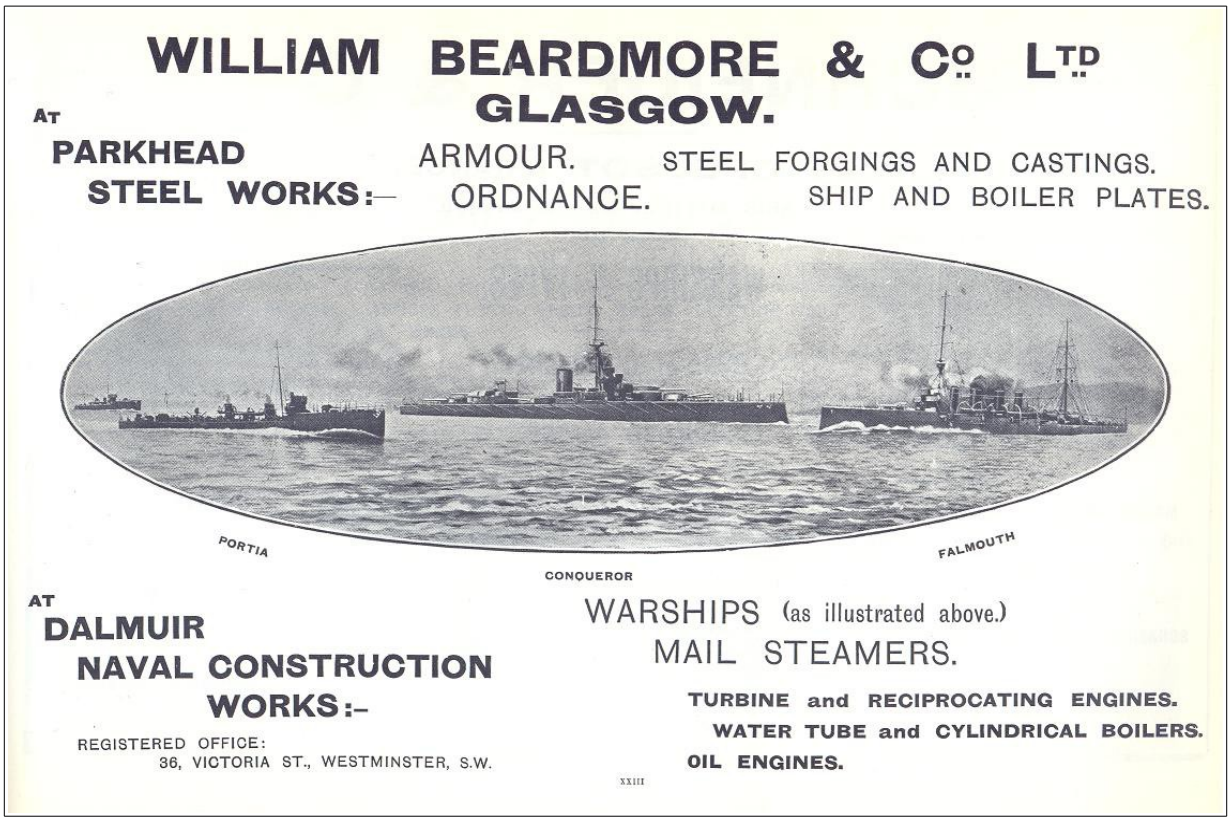
Figure 6.11: C.O.W. corporate structure.



Given the technical complexity of the trade, and the opposition coming from the established producers, it is not surprising that C.O.W. proved to be a source of disappointment for its shareholders. Equipping the plant was very expensive: the few records which survived do not allow a precise estimation, but the costs certainly amounted to several hundreds of thousands of pounds. The fact that the firm did not receive orders from the British government for several years after it was established strongly limited the appeal of its production to foreign customers, which were certainly suspicious of a firm whose products were not purchased by its government. In addition, because gun making required large capital investments, the less the firm produced, the higher was the price it was forced to quote to cover its fixed costs, or it had to bear large losses. As a result, C.O.W. remained unprofitable: between 1910 and 1913 it accumulated total losses equal to the sum

72 *Directory of Army Contracts*, *Report*, 1910, p. 7.
73 NA, ADM, 1/7758, 4 September 1903.

Figure 6.12: Advertisements of various armaments firms which appeared in Brassey's *Naval Annual* in the period 1912-1915. Notice how Armstrong and Vickers stressed the variety of hardware they could supply.



Source: http://www.naval-history.net/

of £432,263.[74] It was only in 1914, which C.O.W., thanks to the orders which the Royal Navy had started awarding it in the context of the naval rearmament of 1912-1914 years, posted for the first time a profit (£58,441).

Foreign ventures and domestic alliances.

Until the beginning of the 20th century few British armaments firms set up foreign subsidiaries or, more generally, invested in production facilities abroad. Apart from Armstrong's investment in Pozzuoli, another case was that of the Placencia de las Armas, which, despite its name, was a British company created in 1887 for the manufacture of ordnance in Spain.[75] Vickers gained the full control over the firm as a result of its merger with Maxim-Nordenfelt in 1897. Placencia produced only small guns (up to 100 mm of calibre), gun mountings and projectiles in its plant in the Basque country. Spain's limited military budget meant that the Placencia remained a small firm – it had an authorised capital of only £40,000. In 1903 Vickers considered liquidating the firm, but it changed its mind. In the following years Placencia's turnover averaged just £8,500 a year and the firm did not make any profit from 1894 to 1910, when it owed Vickers £150,000.[76]

By contrast, from the early 1900s onwards foreign subsidiaries and joint-ventures involving British armaments firms increased both in number and in the amount of capital involved. British armaments companies moved from selling to foreign customers to become partners in local ventures. Such a process did not occur overnight: British firms still dominated the international armaments trade in warships and naval ordnance before the First World War (Trebilcock calculated that between 1900 and 1914, the market share of British firms was equal to 63,2% of total world sales, with French firms distant seconds with a share of just 9.4%).[77] The introduction of dreadnoughts boosted exports in the short-run because British firms were among the few in the world which had actually built them, and thus they could guarantee better construction times. Before 1914 British firms received orders from abroad for 8 dreadnoughts (one from Australia), not counting the vessels built in Spain (see below). In addition, both Austria-Hungary and Russia ordered turbines in Britain for domestically-built dreadnoughts.[78] The tendency towards a different

74 Warren, *Steel*,149.
75 *The Times* 27 March, 1934, 21.
76 VA 1209, *Placencia de las Armas Co., Minute Books (1888-1931)*; and VA 57, *Documents Submitted to the Royal Commission on Private Manufacture of and Trading in Arms*, f. 19
77 Trebilcock, *Vickers*, 123.
78 G. C. Peden, *Arms, Economics and British Strategy: From Dreadnoughts to Hydrogen Bombs* (Cambridge, 2007), 27.

market structure, however, was pronounced.

Vickers did its first large investment abroad in Italy. In 1905 the firm invested £86,625 to set up, together with Terni, the Vickers-Terni company for the manufacture of artillery (a more detailed reconstruction of the Vickers-Terni's development is in the next chapter).[79] A few years later, three of the largest British armaments companies jointly contributed to set up an armaments plant in Spain: after its defeat during the Spanish-American war, the Spanish government decided to rebuild the country's fleet using the most up-to-date naval technology.[80] To achieve this aim, however, Spain decided not to purchase the three dreadnoughts it planned abroad, but to produce them domestically.[81] In 1908 the government awarded the contract for the modernisation of the government's yard in Ferrol and the construction of the dreadnoughts to a new firm, the Socieded Espanola de Construccion Naval.[82] This company was created by Armstrong, Vickers and John Brown (each of them paying £31,450), together with local interests (among them the shipping company Compania Transatlatica and the country's major banks) which accounted for 70% of the initial capital of the firm.[83] Thanks to the contracts received from the government, the firm rapidly turned profitable, starting to pay a dividend of 6-7% a year from 1910 onwards. In addition British shareholders received also payments for the technical support they provided to the new firm. For example, the Sociedad paid Vickers on average £800-900 a year for the designs and technical advices it supplied.

The investment that Armstrong and Vickers jointly undertook in Japan followed a similar pattern. In the course of the 1880s and 1890s Japan had became a very important customer for British armaments companies. After the war with Russia, the Japanese government decided that the development of a domestic armaments industry was essential to enhance the strategic security of the country. The Japanese Navy had fought the war knowing that every vessel it lost was not immediately replaceable because the country lacked a modern armaments industry.[84] While Japanese firms could produce basic hardware, ordnance, gun mountings and large steel forgings needed to be imported from Europe.[85] To favour the transfer of the technology required to produce them, the two major British suppliers to Japan, Armstrong and Vickers, were asked to contribute to the creation of a modern domestic armaments industry. Thus in 1907 Armstrong and Vickers joined

79 VA 683 *Vickers-Terni*.
80 P. G. Halpern, *The Mediterranean Naval Situation, 1908–1914* (Cambridge, 1971), 280-285.
81 Sondhaus, *Warfare*, 215.
82 *The Manchester Guardian*, 1 February 1909,12.
83 VA 57, f. 30 Id. *La Sociedad*.
84 Evans and Peattie, *Kaigun.*, 159-161.
85 Id., 63-64.

the Japanese Hokkaido Coal and Steamship Company to create the Japan Steel Works at Muroran. Each of the two British shareholders paid £250,000, an amount much larger than the one they paid in Spain, a testimony of the scale of the Japanese efforts. In addition, Vickers and Armstrong bound themselves "to give to the Japanese company all such information and advice as may be required in regard to the establishment of the new works and to the working of its business". In compensation for such technical advice "the British companies were to receive the preferential right to manufacture or supply all the machinery, appliances, etc." required.[86] In 1911 the plant started production and soon became profitable.[87] In 1913 the company's profits stayed at £58,320.[88]

Vickers equally profited from the Russian naval rearmament policy which started few years after the end of the conflict with Japan. In 1911 Vickers began to supply the Nicolayev shipyard based in Mykolaiv, the major shipbuilding centre on the Black Sea, with designs; the British firm also provided technical assistance.[89] The following year Vickers took the step of directly entering the Russian market: forming a syndicate with two Russian banks (the Petrograd International and Commercial Bank and the Banque d'Escompte de Petrograd), it prevailed over the combination between Schneider and Putilov, a local armaments company, to receive from the government the contract for the erection of a new gun plant in Tsaritsyn (later known as Stalingrad). The Russian government also promised to award the new firm contracts worth 6-8 million of roubles a year for the following six years.[90] Vickers paid one third (5,000,000 roubles) of the new firm's capital, which was known as the Russian Artillery Works Company. The value of this investment was later assessed by Vickers at £321,937.[91] Vickers also agreed to supply the new firm with technical know-how, designs, etc. in exchange for a 10% of the profits of the company. At the outbreak of the First World War, the Russian company was still busy erecting the works.

The last major investment made abroad by British armaments firms before 1914 was Vickers, John Brown and Armstrong's joint venture in Turkey.[92] In 1913 the three British firms supplanted Ansaldo, which had been expelled from the country because of the Italy-Turkish war, in the management of Constantinople's arsenal.[93] The Turkish government, which maintained the

86 VA, 57, f. 18, *Nihon Seiko Sho (Japan Steelworks)*.
87 T&W, 130/1268, *Minutes*, 14 December 1911; see also Conte-Helm, 'Armstrong's, Vickers and Japan', I. Nish (ed.), *Britain and Japan. Biographical Portraits* (Folkestone, 1994), 99-101.
88 T&W, 130/1268, *Minutes*, 23 April 1914.
89 The text of the agreement in VA, 735, see also VA, 1219.
90 E. R. Goldstein, 'Vickers Limited and the Tsarist Regime', *The Slavonic and East European Review* 58 (1980), 567-568.
91 VA, 1219.
92 The relevant documents are in VA, 26-31.
93 T&W, 130/1268, *Minutes*, 16 October 1913.

controlling share in the new joint-venture, immediately pledged £1,000,000 a year for four years, and promised additional orders in the future.[94] The British firms' task was to modernise the arsenal and the annexed yard to make possible the construction of modern warships which, until now, Turkey had contracted abroad. The outbreak of the war, however, blocked the scheme.

In addition to the major investments actually undertaken, other foreign direct investments were proposed or developed by British armaments firms without being actually carried out. In 1910, for example, Armstrong was approached by John Brown with a plan for "designing and superintending the building and arming of warships in Russia." Elswick, however, declined to enter into the agreement because it was unsure about the value of the Russian market, and the project collapsed.[95]

Despite their different order of magnitude, Placencia and Pozzuoli had in common the fact of being companies which were fully owned by their British shareholders, who managed them in complete autonomy. By contrast, the wave of investments and agreements of the 1900s and early 1910s was based on a completely different model, characterized by two features. First, British armaments firms did not operate autonomously, but entered into agreements with local partners which usually owned the controlling interest in the newly created joint-ventures. Second, British firms mainly contributed technology and know-how, while it was the local partners which provided the majority of the capital and took care of the sales and management of the operations.

These arrangements highlight two important aspects. The first was the high level of appreciation that the technical skills of British firms enjoyed in armament production, especially of naval hardware, as it is demonstrated by the fact that all projects which were primarily focused on naval armaments saw a British firm among the participants. The second point was the changing nature of the international armaments market in the early 20th century. Until well into the 1890s, outside the few European great powers which could count on a domestic armaments industry formed by a mix of private and public establishments, and the United States, no country in the world had either the financial resources or the industrial capabilities to produce the most sophisticated pieces of military technology. Governments which wished to reinforce their armed forces had to import armaments, if not directly buy fully equipped vessels.

Italy in the course of the 1880s was the first country to try to foster the creation of a domestic armaments industry which could replace external sources of supply. Starting from the 1900s, countries such as Japan, Spain and Turkey all tried to achieve the same: moving, more or

94 Scott, *Vickers*, 85-86.
95 T&W, 130/1268, *Minutes*, 3 November 1910 and 17 November 1910.

less successfully, from the position of purchasers of armaments technology, toward one in which at least part of the more complex production activities were carried on inside their borders. This was because these countries were either becoming richer (Japan), or because they decided to heavily invest in the modernisation of their armed forces (for example, Turkey). For strategic and political reasons it became unpalatable to keep relying on armaments imported from outside.

Under these circumstances, the role of the companies which until then had provided armaments moved, thus, from that of suppliers of finished goods toward that of providers of technology and know-how to local partners. Such a trend involved not only British firms – although their predominance in the international market of armaments meant that they ended involved in many joint-ventures and agreements – but also French and, to a less extent, Italian companies.[96] These agreements could potentiality damage the operations of established armaments makers by fostering new competitors, and thus private firms tried to reduce their scope by adding, for example, clauses which limited the export activities of the new joint-ventures. For instance, the agreement between Vickers and its Russian partners limited the export activities of the Russian Artillery Works to Serbia, Montenegro and Bulgaria, all countries in which Russia enjoyed a high degree of influence and were had never been important customers of Vickers. In general, the reasons why private armaments firms accepted to enter into these agreements have been effectively summarised by Peter Gatrell speaking about the Russian case: "Companies such as Vickers, Krupp and Schneider knew that they could never flood the Russian market with weapons and ships manufactured abroad. The only sensible strategy was to participate in the creation or reorganization of Russian firms, using foreign financial resources and technological lead as bargaining counters."[97] Exactly because of their leading position in the international armaments market, British firms were in danger of losing the most if governments which in the past had been a good customers decided to foster a domestic armaments industry. They were also aware that, in case they would refuse, companies from other countries would have certainly been willing to take their places. It was preferable, therefore, to participate in this process by entering into agreements with local firms and try to squeeze the best possible deal out of such arrangements.

Apart from these joint-ventures and foreign ventures, British armaments firms participated

96 For example, on Schneider's ventures in Russia see C. Beaud, 'De l'Expansion Internationale à la Multinationale Schneider en Russie (1896-1914)', *Histoire, Économie et Société* 4 (1985), 575-602.

97 P. Gatrell, *Government, Industry and Rearmament in Russia, 1900-1914. The Last Argument of Tsarism* (Cambridge, 1994), 235.

to the two major international agreements involving armaments firms: the Harvey and the Nickel syndicates. The Harvey syndicate, whose origins have been described previously, maintained the control of the patents needed for the manufacture of Harvey and Krupp armour plates. The importance of these patents is made evident by the fact that among the first thing Armstrong did when it started to undertake armour production was to apply for membership of the Harvey Syndicate. As the minutes of the company's special committee on armour plate report: "Falkner [the firm's secretary and a member of the board] had been sent to Germany to speak with Mr Krupp to enquire whether Armstrong can gain, and on what terms, membership in the syndicate which controls Harvey and Krupp patents."[98] Armstrong eventually gained membership to the Harvey syndicate, although after protracted discussions which, presumably, revolved around the amount of money Armstrong had to pay to the Harvey company.[99] Armstrong needed to gain access to the patents to produce the most advanced armour plates: Armstrong could potentially have tried to come out with its own manufacturing system, but this would have been an uncertain and costly process. At the same time, it was much more convenient for the shareholders of the various Harvey companies to accept a new partner, rather than risking to foster a competitor. The various Harvey companies, which had gone through a process of partial consolidation, were put in voluntary liquidation in 1911, when Harvey and Krupp's patents expired.

The second international agreements in which British armaments firms were involved was the Nickel syndicate. Nickel was an essential component for hardening armour plates. Armour makers were the largest consumers of nickel before 1914 and thus had a crucial interest in securing a reliable source of supply. Until 1914, the great majority of nickel consumed in the world was dig either in New Caledonia or in Canada.[100] In 1901 Vickers, John Brown, Beardmore, Cammell and Armstrong formed the Steel Manufacturers' Nickel Syndicate Ltd., to pool their purchases of nickel from La Société de Nickel, the French firm controlling the New Caledonia nickel mines.[101] Such an arrangement allowed these firms to obtain better and more stable prices and more favourable conditions.[102] Vickers was entrusted with the administrative tasks of the syndicate.[103] All the syndicate's members apart from Armstrong also established the Anglo-French Nickel Company

98 T&W, 130/1280, *Minutes of the armour plate committee*, 24 November 1898.
99 T&W, 130/1266, *Minutes*, 14 September 1900.
100 F. B. Howard-White, *Nickel: A Historical Review* (London, 1963), 130-131.
101 G. Boyce, 'The Steel Manufacturers' Nickel Syndicate Ltd., 1901-1939: Assessing the Conduct and Performance of a Cooperative Purchasing Organisation', *Australian Economic History Review* 38 (1998), 157.
102 Unfortunately, the records of the Syndicate for the pre-1918 period have only partially survived. For example, data on purchases and the text of the agreement between the syndicate and the La Société de Nickel are lost.
103 VA 57, 3 November 1903.

which owned a nickel refinery in Swansea which supplied them with the majority of the refined metal they needed. In the years from 1901 to 1908 Schneider, Krupp, Terni and a few other firms joined the syndicate.[104] Whatever the divergences between the various European governments, the decision to open the syndicate to the major firms of other countries was rational, because the more firms belonged to the syndicate, the stronger it would become its market power versus La Société de Nickel and the few other nickel suppliers.

A peculiar feature of the British armaments industry before 1914 was the high degree of collaboration which existed between the various firms. This was a peculiarity of the British armaments market. At the opposite, for example, both in Italy and in Germany, armaments firms strongly competed against each other.[105] The above discussion on foreign joint-ventures had already pointed to the many occasions in which Armstrong and Vickers collaborated, sometimes also in agreement with John Brown.

The large expansion of Vickers after 1897 was a reason of concern for Armstrong's management. The fact that Vickers had expanded to naval construction meant that Armstrong lost its position as the only armaments firm with an autonomous shipbuilding capacity in Britain. As it has been said before, one of the reasons Armstrong decided to merger with Whitworth was exactly to prevent the Manchester-based firm being bought by its Sheffield rival. Vickers rapidly evolved in the early 1900s while Armstrong was hampered by the fact that, after the death of Lord Armstrong in 1900, its board was split between two competing groups. Both firms, however, recognised that excessive competition could damage their operations.

It is important to draw a distinction between the domestic and the foreign markets. In Britain, starting from the late 1890s, the allocation of orders was not exclusively the result of market dynamics. The Admiralty awarded contracts taking into consideration the estimates submitted by the firms competing for contracts, but it also aimed to enlarge the number of companies producing certain kind of products, so as to increase competition and drive down prices and also to make possible, in case of war, for the private sector could rapidly escalate production. This explains, for example, why the Admiralty favoured the enlargement first of Whitworth and later of the C.O.W.: it wanted to be able to count on an additional gun making firm. Obviously, the

104 VA 1198, *Minutes of the Board of the Steel Manufacturers' Nickel Syndicate* (1901-1935), *passim.*

105 For the Italian case see next chapter. In Germany a working agreement between Krupp and the major naval shipbuilders was reached only in 1913, M. Epkenhans, 'Military-Industrial Relations in Imperial Germany, 1870-1914', *War and History* 10 (2003), 18-19.

Admiralty maintained strict quality requirements which had to be meet by potential suppliers, as Cammell's temporary exclusion from the list of suppliers testify. This fact meant that domestic competition in Britain was somehow tempered. Firms had the incentive to develop technical know-how so as to maintain, or gain, a leading position in certain niches (as Vickers was able to do for submarines for a while, or as Armstrong and Vickers did for gun mountings for large naval guns), but non-economic considerations played also a role. As the trade journal *Arms and Explosives* suggested: "the orders of a given year must be distributed so as to maintain private factories in efficient condition, during periods of limited demand. Capital must be maintained intact, and staffs must not be dissipated." For this reason collaboration between firms was required "to maintain manufacturing facilities intact for the time when the strain of exceptional demand arises."[106]

It was especially important to arrive at some sort of agreement about foreign markets. At the turn of the century, Ansaldo and Orlando had sold cruisers to Argentina, Chile, Spain and Japan, markets which had been usually supplied exclusively by British companies. At the same time, French and German firms, and later also American ones, were trying to conquer a larger share of the world market for naval constructions and artillery. In 1906 Armstrong and Vickers arrived at an understanding about foreign orders. As stated in a confidential report produced for Armstrong's board, presumably in 1913:

> The arrangements with Vickers … have been made so far as possible with a view of dividing the work equally between the two firms. … The object underlying them is, of course, to prevent unnecessary cutting of prices and, where possible, to bring the work to England. This policy has been successful in particular in Spain, Turkey and latterly in Chile. It was suggested that figures should be prepared to show the advantage gained by the firm by entering into such arrangements, but it appears impossible to do so. It is probable, however, that in their absence, competition between the two firms would reduce profits to vanishing points. Italy may be instanced as a particular example.

The document continues presenting the various arrangements which existed in relations to different countries.

106 *Arms and Explosives*, October 1913, 139.

> ITALY: comparison of prices only. The government at present divides orders between Vickers-Terni group and ourselves equally.
> GREECE: agreement between Armstrong and Vickers. The maker pays [to the other] 2% of the price of the hull, £6 per ton on hull armour, £15 per ton for shield, 10% on guns and mountings. Nothing on machinery.
> CHILE: agreement between Armstrong and Vickers. The builder pays [to the other] 12.5% on armaments, £6 per ton on hull armour, £15 per ton for shield, 7.5% on coast defence guns and mountings.
> TURKEY: agreement between Armstrong, Vickers and John Brown. Vickers build hull and machinery, Armstrong and Vickers divide armaments [among themselves], Armstrong, Vickers and John Brown divide armour, Armstrong and John Brown divide shafting, etc. Vickers will stand out of hull and engines of the next ship.[107]

Armstrong and Vickers also collaborated to split the Argentine orders for two dreadnoughts among themselves.[108] British armaments makers were at the forefront of naval technology, their vertically integrated structures helped them to be competitive in the international markets. At the same time, however, their relative position was reinforced by agreements among themselves.

6.4 *Conclusions.*

The wave of mergers and acquisitions of the late 1890s deeply reshaped the British armaments industry. Both new entrants and established firms tried to vertically integrate production, from gun and armour making to naval shipbuilding. The growing British naval budget offered potential new large business opportunities. Moreover, the introduction of dreadnoughts offered the chance to gain additional orders from both the Royal Navy and foreign governments. An additional development which occurred in the decade before 1914 was the growing number of foreign joint-ventures involving British armaments firms, especially Armstrong and Vickers, which in the previous decades had been the most active companies on foreign markets.

At the same time, not all British armaments firms were equally successful in their integration of various productions, or equally profitable. Acquiring and developing technical

107 VA 551.
108 T&W 130/1267, *Minutes*, 21 January 1909; and VA, 1005, *Letter Book n. 31*, 14, 15 and 31 December 1909.

capacity in the most complex fields – gun and armour making – proved to be difficult and costly, as the case of Beardmore shows: the large expansion plan which the firm pursued translated in few orders and poor returns. An analysis of the dividends paid by the major British armaments firms in this period offers a partial, but still useful, way to assess their different performances (figure 6.13).

Figure 6.13: Dividends paid by major British armaments firms as percentage of the firms' capital, 1898-1912.

Year	Armstrong	Vickers	CammLa	J. Brown	Beardmore
1898	15	15	15	6.66	-
1899	20	20	17.5	10	-
1900	20	20	17.5	15	-
1901	12.5	15	15	20	-
1902	15	12.5	10	15	0
1903	15	10	7.5	10	7.5
1904	15	12.5	7.5	8.33	6
1905	15	15	10	8.33	6
1906	15	15	10	10	0
1907	15	15	2.5	10	0
1908	10	10	0	10	0
1909	10	10	0	7.5	0
1910	10	10	7.5	7.5	0
1911	12.5	10	7.5	7.5	5
1912	12.5	10	10	7.5	5
1913	12.5	12.5	2.5	7.5	5
Average	14.1	13.1	8.75	3.4	9.75
σ	2.91	3.27	5.45	2.92	3.93

Source: Vickers, John Brown, Cammell Laird: G. Tweedale, *Steel City. Entrepreneurship, Strategy, and Technology in Sheffield, 1743-1993* (Oxford, 1995), 124-125; Armstrong and Beardmore: Warren, *Armstrongs of Elswick: Growth in Engineering and Armaments to the Merger with Vickers* (Basingstoke, 1989), 161. For missing years: *Stock Exchange Yearbook*, various years.

At the turn of the century, the combination between the Second Boer War and the British naval build-up resulted in an unprecedented high level of profitability for all the major armaments

firms, a level which which was not matched until the First World War. By contrast, the second half of the 1900s was a less profitable period because of the fall in naval appropriation. In addition to this, Cammell Laird suffered from its temporary exclusion from the list of suppliers for the Navy and the Army. Armstrong and Vickers paid in average much higher dividends than the other firms. Their presence in foreign markets and their strong export activities helped them to weather far better then their rivals the ups and downs of the domestic market. Finally, Beardmore is a clear outlier among the armaments firms: it paid very low dividends throughout the entire period.

Chapter VII

In Search of Vertical Integration: The Italian Armaments Industry, 1900-1914

This chapter analyses the evolution of the armaments industry in Italy from the early 1900s to 1914. Several key trends characterised this period. First, as in Britain, technological evolution, the search for economies of scale and the desire to add additional productions pushed Italian armaments firms towards making large investments and integrate vertically. By contrast, however, Italian firms fiercely competed among themselves: any attempts to reach an agreement between them failed.

Second, despite their technical progress, Italian firms still needed to import cutting-edge technology and know-how. The importance of access to foreign technology was magnified by the appearance of dreadnought vessels. However, the way in which foreign technology was introduced in the country changed: while in previous decades foreign technology had been mainly introduced as semi-processed or finished goods, in these years, alliances, joint ventures and licences became the most common ways to gain access to it.

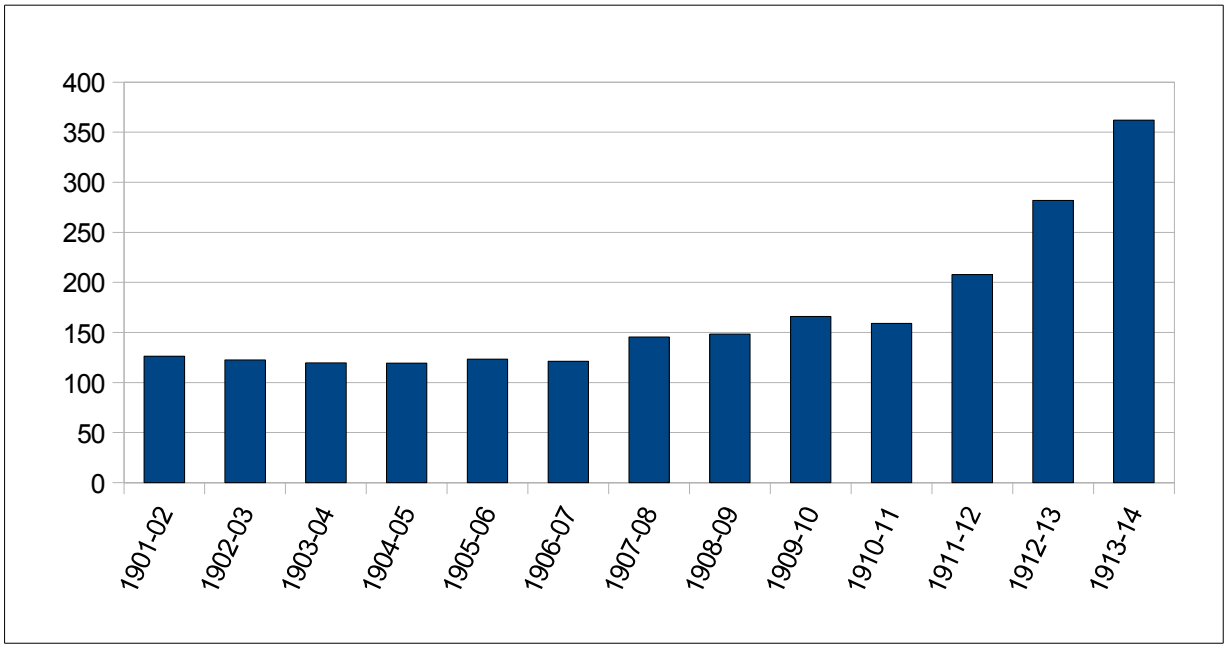
The years covered in this chapter can be divided into two periods: one from the early 1900s to 1908, the other from 1908 to 1914. During the first period a general reorganisation of the sector occurred: both Ansaldo and Terni changed ownership, and Armstrong entered into a temporary alliance with Ansaldo. During the second period, the Italian navy budget grew significantly, and both Ansaldo and the Terni fully pursed vertical integration: by 1914, both major Italian armaments groups were able to produce all the components of a battleship: hulls, engines, armour plates and guns.

The chapter is structured as follow: the first part presents the trends of Italian naval spending and the military and strategic context which influenced it. The second offers a general summary of the evolution of the sector during this period addressing the evolving strategies of the various armaments firms.

7.1 *Italian naval spending 1901-14*.

In the period 1901-14 Italian naval spending tripled (Figure 7.1). Naval spending can be divided into three periods. The first ran from 1901 to 1906. During these years the naval budget remained around 120 million Lire, the level it had reached in the late 1890s. In 1902, Italy and France arrived at an understanding about their respective spheres of interests in Morocco and Libya.[1] In 1906, Britain and France recognised the pre-eminence of Italian interests in Ethiopia.[2] These agreements eased the tension with France, which translated into moderate naval spending.

Figure 7.1: Italian naval spending 1901-1914 (in current Lire).



Source: Ragioneria Generale dello Stato, *Il Bilancio del Regno d'Italia negli Esercizi Finanziari dal 1862 al 1912-13* (Roma, 1914), and id. *Il Bilancio dello Stato dal 1913-14 al 1929-30* (Roma, 1931), *passim.*

The second period, between 1907 and 1910, was characterised by increases averaging 10% a year. In 1907 the budget reached for the first time a level higher, in real terms, to the previous peak in 1889. The annexation of Bosnia rekindled Italian hostility against Austria, despite both countries

1 S. Romano, 'Il Riavvicinamento Italo-Francese del 1900-1902: Diplomazia e Modelli di Sviluppo', *Storia Contemporanea* 9 (1978), 105-114.
2 C. Seton-Watson, *Italy from Liberalism to Fascism: 1870-1925* (London, 1967), 362.

belonged to the Triple Alliance. In 1909 Italy laid down its first dreadnought, the *Dante Alighieri* (the first capital ship in the world equipped with turrets mounting three guns each), starting a naval race with Austria in the Adriatic Sea.[3] By 1910 the naval budget exceed 150 million Lire. During the third period, from 1911 to 1914, the naval budget rose to unprecedented levels until, in fiscal year 1913-14, it exceeded 350 million Lire, more than twice the amount of 1909.

In the years 1910-1914 the naval race with Austria-Hungary intensified. At the end of 1910 Italy ordered three additional dreadnoughts: *Conte di Cavour* (built by the Spezia arsenal), *Leonardo da Vinci* (Odero) and *Giulio Cesare* (Ansaldo). These vessels deployed 13 12 in. guns and displaced around 23,000 tons, a 75% increase over the last Italian pre-dreadnought battleships. Austria replied by laying down two dreadnoughts in 1910 (*Viribus Unitis* and *Tegetthoff*) and two more in 1912 (*Prinz Eugen* and *Szent István*). Italy responded by ordering two ships in 1912, *Andrea Doria* (built in Spezia) and *Caio Duilio* (Castellammare). In 1914 both countries planned to built super-dreadnoughts displacing more than 30,000 tons but the outbreak of the war stopped their construction.

An additional reason which drove up Italian naval expenditure was the Italo-Turkish war in 1911-12.[4] As in the case of the Boer War, this conflict highlighted the crucial role played by naval power: the Italian expedition force in Libya was unable to overcome the resistance in the interior of the country (until the 1920s, Italian control was limited to the coast).[5] The war was brought to a rapid conclusion by the naval operations in the East Mediterranean which included the occupation of Rhodes.[6] The war momentarily reversed the rapprochement with France and Britain, and drove Italy again closer to its partners in the Triple alliance (although it did not stop the naval race in the Adriatic).

As in Britain, the Italian naval budget changed in composition while it expanded. The less detailed data available do not allow to repeat the analysis done for the British budget, but it is possible to calculate that, starting from 1908, the resources allocated for the construction of vessels from private yards exceeded those used to carry out construction in public arsenals (Figure 7.2).

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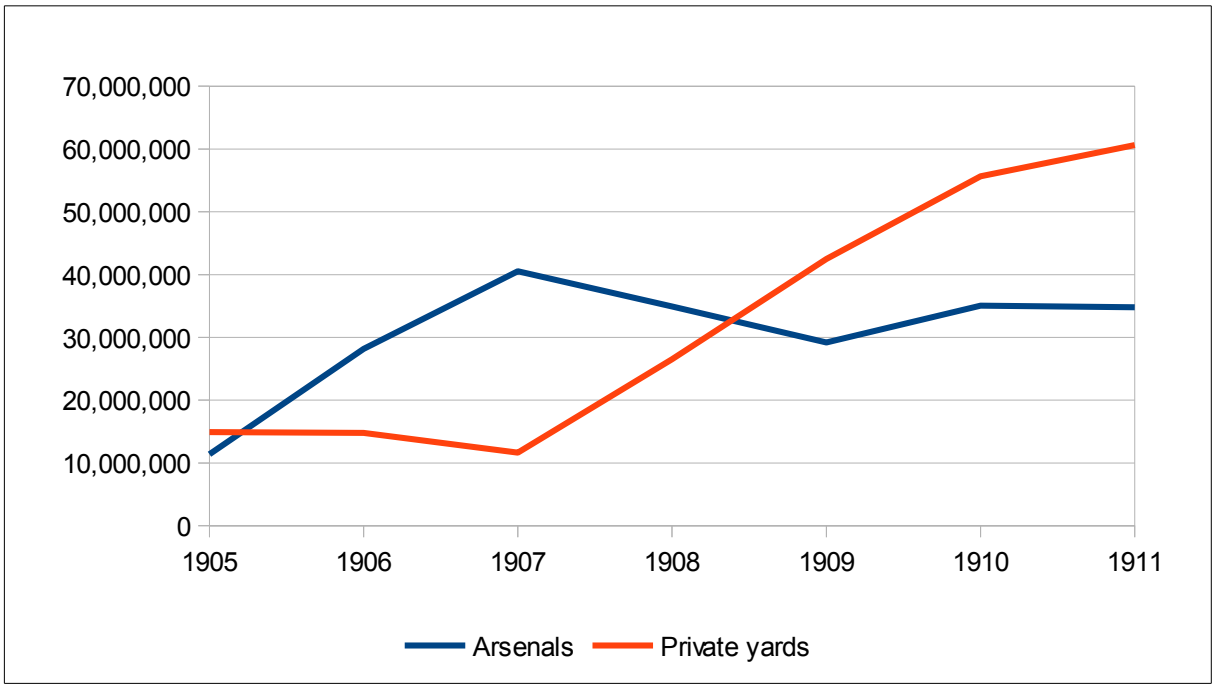
3 L. Sondhaus, *Naval Warfare 1815-1914* (London, 2001), 209-213; id. *The Naval Policy of Austria-Hungary, 1867-1918: Navalism, Industrial Development, and the Politics of Dualism* (West Lafayette, 1994), 191-203; M. N. Vego, *Austro-Hungarian Naval Policy, 1904-14* (Portland, 1996) 1-3 and 66-113..

4 A. Del Boca, *Gli Italiani in Libia: Tripoli Bel Suol d'Amore, 1860-1922* (Roma-Bari, 1986), T. W. Childs, *Italo-Turkish Diplomacy and the War Over Libya, 1911–1912* (Leiden, 1990), and N. Labanca*, Oltremare. Storia dell'Espansione Coloniale Italiana* (Bologna, 2007), *passim.*

5 A. Del Boca, *Gli Italiani in Libia: dal Fascismo a Gheddafi* (Roma-Bari, 1986), chapters 1-3, N. Labanca, *La Guerra di Libia 1911-1931* (Bologna, 2012).

6 M. Gabriele, *La Marina nella Guerra Italo-turca* (Roma, 1998).

Figure 7.2: Italian navy shipbuilding expenditures, 1905-1912 (in million of current Lire).



Source: *Rendiconto Generale Consultivo dell'Amministrazione dello Stato*, from 1904-1905 to 1910-1911.

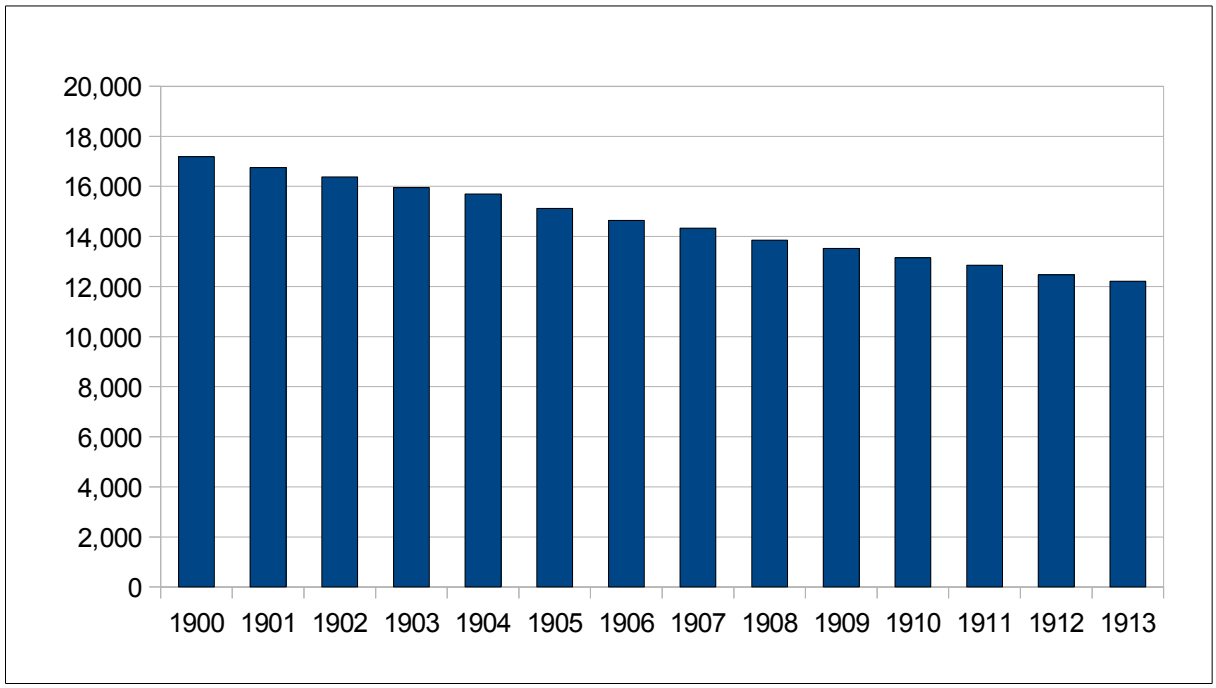
In the early 1900s the Italian navy ordered few new vessels. This explains the low level of expenditure in 1905. In 1906 and 1907 additional resources initially benefited government arsenals. In 1908 private firms started to enjoy an unprecedented rise in orders, mainly generated by the construction of the new dreadnoughts. In contrary, the share of resources going to arsenals remained flat. The relative decline of arsenals is also highlighted by the dwindling number of their workforce from 1900 onwards (Figure 7.3).

Arsenal workers fell from 17,000 in 1900 to 12,000 in 1914, a reduction of near 30%. The large expansion of arsenals during the 1880s had been halted in the 1890s. A reduction of workforce was unavoidable, because there were too many arsenals, which were therefore underused.[7] In addition, because of the growing share of constructions carried on by private firms, arsenals focused more on repairs and general maintenance, reducing the need for a large workforce. For political

7 The Ministry calculated that to keep all arsenals busy the construction budget should have doubled and be entirely spent there, see Ministero della Marina, Ufficio del Capo di Stato Maggiore, *Annali della Scuola Navale di Guerra, 1908* (Roma, 1908), 205.

reasons, however, it was difficult to close or sell any arsenal outright, but the Navy cut costs by reducing personnel. All arsenals saw a decline in their workforces, but the one in Venice was the most hit: it was too old, difficult to defend, and the lagoon was too shallow to be easily navigated by the largest vessels. Workers there felt from more than 3,300 in 1900 to less than 2,000 in 1913.

Figure 7.3: Number of workers employed by Italian naval arsenals, 1900-1913.



Source: Camera dei Deputati, *Stato di Previsione della Spesa per l'Esercizio Finanziario 1913-1914*.

9.2 *The evolution of the armaments sector, 1900-14*.

In the decade before 1914, both Ansaldo and Terni integrated vertically, increasing the range of productions they could make "in house". The organisational, technological, financial and commercial reasons behind this strategy were the same which explain the similar moves made by British armaments companies with, in addition, the fact that foreign firms provided Italian companies with a model they could follow. It must be stressed, however, that despite the managements of Terni and Ansaldo repeatedly expressing their intention to increase the range of their productions, both firms achieved their aims only in the early 1910s. This was because such

strategy was costly: technical capabilities and know-how had to be gained, complex organisational challenges had to be solved and large financial costs sustained.

Odero, Orlando and Terni

A series of changes in the ownership of the major Italian armaments firms occurred in the early 1900s. In the late 1890s, Giuseppe Orlando and Attilio Odero started to acquire shares of Terni taking advantage of the desire of several shareholders to to cash their investment.[8] Their aim was to link Terni with their shipbuilding activities: their yards were among the major purchasers of steel forgings and armour plates, and a combination could greatly reinforced them. Terni's share of national production had been falling since the early 1890s. In 1903 it produced 18,637 tons of steel (half of it was for military purposes), representing 11.35% of Italian total steel production. The firm's strength, however, did not lie in the quantity of output, but in its quality and its monopoly of military goods. Terni was tuned to perform high-quality production: it was the only firm in Italy which had Bessemer converters in operation, which were the most suitable process for making the special steel alloys employed in armaments, because they allowed to precisely alter the chemical composition of steel during production.[9]

In 1898 Terni's shares started to be quoted on the various Italian exchanges. During the first months of 1899, because of large acquisitions, their price moved up from around 1150 Lire to more than 1650 in just a few months.[10] The 1899 shareholders' meeting revealed the presence of a group of investors organised by Odero and Orlando.[11] From 1899 to 1903, the year Breda died, major disputes took place in the firm's board between Breda, on one side, who wanted to keep Terni independent, and the Orlando-Odero group, which, at the opposite, was in favour of stronger links between Terni and the shipbuilding firms.[12] Eventually, in 1904, Terni acquired Odero's and Orlando's yards.

To gain the control of Terni, Odero and Orlando allied themselves with a group of stock

8 By 1899 Attilio Odero had invested around 1,6 million Lire in Terni's shares, G. Doria, *Investimenti e Sviluppo Eonomico a Genova alla Vigilia della Prima Guerra Mondiale*, vol. 2, *1883-1914* (Milano, 1973), 667-670.

9 R. Giannetti, *Tecnologia e Sviluppo Economico Italiano, 1870-1990* (Bologna, 1998), 87.

10 The on-line archive of *La Stampa* offers the possibility to check the price of Terni's shares at the Genoa stock exchange on a daily basis.

11 AST, Fondo Terni, *Verbali dell'Assemblea degli Azionisti 1899*. Because Terni's statue initially limited the number of delegations which each participant could have, that year twenty four shareholders participated in representation of one hundred and three investors. Subsequently, these limits were cancelled, allowing the pooling of large numbers of shares.

12 F. Bonelli, *Lo Sviluppo di una Grande Impresa in Italia: la Terni dal 1884 al 1962* (Torino, 1975), 69-82.

exchange speculators, among them Eugenio Scartezzini e Ferruccio Prina.[13] Their holdings of shares guaranteed Odero and Orlando a majority in the assembly. The new controlling group, however, did not have a coherent design. Whereas Odero and Orlando's primary aim was integrating the operations of Terni with that of their yards, Scartezzini and Prina wanted Terni to distribute large dividends, also out of borrowed resources, which they could used to finance stock exchange speculations. As a result, between 1899 and 1906 the share of Terni's profits distributed to shareholders jumped from 11,7% of the firm's profits (in average 700,000 Lire a year from 1893 to 1898) to 44,2% (in average more than 3 million Lire a year). 1905 was a record year: 4,35 million Lire were returned to the shareholders, the higher absolute value ever registered before the First World War.[14] To finance this generous policy, depreciations were halved. In addition the firm's liquidity was "lent" to Scartezzini and Prina to pursue financial operations: in the period 1903-1906, financial returns accounted for more than 40% of the firm's profits. As Franco Bonelli has written: "the management of Terni between 1899 and 1906 is the convulsed history of the alliance between stock exchange, banking and industrial interests."[15] The import role of these financiers is testified by the fact that, between 1904 and 1906, Ferruccio Prina was Terni's chairman. In general, during the period 1900-1906, the industrial side of the Odero-Terni-Orlando nexus was sidelined in favour of financial engineering, at least until first Scartezzini (in 1901) and later Prina (in 1906) were forced to leave because of the large losses they had incurred in their trading speculations.[16]

The early years of Odero and Orlando's management were also complicated by the outbreak of the "Terni scandal": in 1903 the socialist MP Enrico Ferri mounted an attack from the columns of the socialist newspaper *L'Avanti* against the Minister for the Navy Giovanni Bettolo and the management of Terni. Ferri accused Bettolo of having illegitimately favoured Terni by awarding the company contracts for armour plates which commanded unjustified high prices. The fact that Terni was distributing high dividends seemed to confirm this. In addition, Ferri implied that Bettolo had personally gained from speculating on Terni's shares. Bettolo sued Ferri for defamation (he won the trial), claiming that Ferri was motivated by political reasons.[17] The Ferri-Bettolo controversy led the following year to the creation of a parliamentary inquiry commission on the Navy's procurement

13 On the activities of these financiers see Doria, *Investimenti e Sviluppo*, 314, 389, 555, 654 and 716-17 (which offer a list of Prina's investments up to 1906).

14 F. Bonelli, *Terni*, statistical appendix.

15 Bonelli, *Terni*, 71.

16 On Prina's operations, which left Terni with a loss of 600,000 Lire, see *La Stampa* 25 October 1906; on his resignation *La Stampa* 19 November 1906, 3.

17 R. Guêze, 'Bettolo, Giovanni', *DBI*; and G. Sircana, 'Ferri, Enrico', *DBI*. F. M. Baratelli, *La Marina Militare Italiana nella Vita Nazionale (1860-1914)* (Milano, 1983), 326-327.

activities, which was followed three years later by an analogous commission on the Army.[18] These commissions were the only opportunity MPs had to scrutinize the internal affairs of the armed forces, a topic which was usually considered "unpatriotic" to discuss, before the end of the First World War.[19]

The final report of the Inquire Commission criticised Terni for having overcharged in the past the government for its supply of armour plates. The commission also stigmatized high ranking military officers who, after retiring from service, went to work for the same firms with which they had dealt with while in office (for example, the last three general directors of Terni were all former naval officers). The conclusions reached by the commission were widely reported in the press (Figure 7.4), but the polemic was rapidly sidelined by other events and the control exercised by the parliament over the armed forces and their budgets remained feeble.[20] For instance, the efforts of the Advisory Commission on State Procurement – a body created in 1912 inside the prime minister's office – to rationalise armaments spending by increasing the exchange of information between government offices, private industries, and parliament led to nothing. Also the attempt made in 1913 to cut the links between civil suppliers and the government bureaucracy by making illegal for any former civil servant and military officer to do business with the public administration, was equally frustrated.[21]

Discussing the conclusions of the Inquiry Commission, Orlando and Ordero claimed that Terni was the target of a slanderous campaign organised by the socialist party and supported by industrial rivals – it is evident they were thinking off Ansaldo.[22] It is hard, however, to believe this: Ansaldo and Armstrong had equally been criticised by the Commission because of the presence of Albini in their boards. During the meeting it was also suggested that Terni could make public its balance sheets so as to demonstrate the correctness of the prices it quoted to the government. Orlando and Oddero opposed the motion, however. In fact, Terni's accounts were less then transparent. For example, there is no trace in the minutes of the price Terni paid in 1904 to purchase 70% of the capital of Orlando and Odero's yards. Between 1903 and 1904, however, the value of the

18 R. Chiarini, 'Ambizioni e Difficoltà di un Progetto Riformatore', id. (ed.), *Alle Origini dell'Età Giolittiana. La Svolta Liberale del Governo Zanardelli-Giolitti 1901-1903* (Venezia, 2003), 49 and 51-52 offers an explanation of Gioliti's support for the enquire, even though it was strongly opposed by the king and the Navy.

19 P. Ferrari, *Verso la Guerra. L'Italia nella Corsa agli Armamenti 1884-1918* (Vicenza, 2003), 166-182.

20 Id., 'Amministrazioni Statali e Industrie nell'Età Giolittiana. Le Commesse Pubbliche tra Riarmo e Crisi Economica 1911-194', *Italia Contemporanea* 180 (1990), 451-479.

21 Id., 'Corruption in Italy: a Structural Approach', S. Tiihonen (ed.), *The History of Corruption in Central Government* (Amsterdam, 2003), 165-178.

22 AST, FT, b. 71, *Verbali del Comitato Esecutivo*, 7 May 1906, and b. 38, *Verbali del Consiglio di Amministrazioni*, 7 May 1906.

Figure 7.4: The front page of the newspaper *La Stampa*, 1 May 1906. The title is “New serious revelations of the Enquiry on the navy”. The subtitle refers to “Scandalous favours for Terni. Price increases of million, beyond the agreed one”.


ANNO XL — MATTINO

TORINO, Martedì 1° Maggio 1906

MATTINO — NUM. 119

LA STAMPA

GAZZETTA PIEMONTESE

Nuove gravissime rivelazioni dell'inchiesta sulla marina da guerra.

Scandalosi favori alle Terni - Milioni di aumento oltre il pattuito - Le impressionanti conclusioni sulla questione delle corazze, dei cannoni, dei proiettili, dei carboni e dei sistemi di collaudo - L'odissea di un ufficiale onesto - La questione dei viveri - Magazzini sprovvisti - Pane cattivo - Sostanze adulterate - Contratti mal compilati - Guadagni illeciti.

(Per telefono alla STAMPA)

Traditori della patria!

Source: http://www.archiviolastampa.it.

entry “industrial holdings” in Terni's balance sheets increased from 4,273,028 Lire to 14,023,046.[23] According to Giorgio Doria, who made use of contemporary journalistic sources, Odero's two yards in Genoa were paid a total of 3,2 million Lire.[24] This means that Orlando's yard could have been paid up to 6,8 million Lire, although the price was probably a bit lower. Terni left the managerial control over the yards' operations to their previous owners, which were paid part in cash and part in newly issued Terni's shares.[25] Orlando and Odero thus gained twice from the sale because, in addition to the money, they strengthened their control over Terni by increasing their shareholdings.

Among the survived records, there is no trace of the final year results of the different units (steel works, yards, etc.) of Terni. Fragmented data on intra group sales show that the price at which transfers of forgings, plates and armours were recorded varied considerably. Sometimes yards bought supplies from the steelworks at high prices while, in other occasions, they did not pay at all.[26] While it is impossible to arrive at any precise conclusion about the final year results of the yards, something can be said about their constructions activities. After the delivery of the last *Garibaldi* cruiser, the number of ships built for foreign governments felt significantly: Odero built two gunboats (1,200 tons each) for the Mexican government in 1903, but from that moment it exported nothing. The performance of Orlando's yard was brighter: in 1909 it sold an armoured cruiser originally intended for the Italian navy to Greece for £950,000 (that is 23,750,000 Lire).[27] The *Georgios Averof* (10,000 tons) is still the largest ship ever built in Italy for a foreign customer.[28]

Italian orders, therefore, came to represent the major source of military works. In this field, the Odero yard obtained more orders than Orlando. In fact after Orlando launched in 1907 the armoured cruiser *Pisa* and two 10,000 tons auxiliary vessels, it only built several destroyers of 800-900 tons each. Only in 1914 Orlando was awarded the contract for one of the super-dreadnoughts whose construction was cancelled during the war. Odero, at the opposite, built for the Italian navy the dreadnought *Leonardo da Vinci* (a contract worth 70 million Lire),[29] plus destroyers, submarines and torpedo boats. Despite the absence of any evidence, it is highly probable that Orlando and Odero had an agreement on how to divide shipbuilding activities among themselves. In 1911,

23 AST, Fondo Terni, b. 308.
24 Doria, *Investimenti*, 667.
25 AST, FT, bb. 37 and 38, *Verbali del Consiglio di Amministrazione*, 26 January and 23 February 1904.
26 Bonelli, *Terni*, 104.
27 G. F. Martorelli, ‘La Industria delle Costruzioni Navali in Italia (1861-1911)’, *Rivista Marittima* 43 (1911), 16. The *Georgios Averof* is now as a museum ship, the only pre-dreadnought capital vessel still in existence which has not been largely reconstructed.
28 E. Bagnasco and A. Rastelli, ‘Le Costruzioni Navali Italiane per l'Estero’, special issue of *Rivista Marittima*, December 1991.
29 G. Giorgerini and A. Nani, *Le Navi di Linea Italiane 1861-1961* (Roma, 1962), 121-22.

Orlando yard employed around 2,800 workers, and, with an extension of 150,000 square meters, it had tripled the surface it occupied in 1866. In the same year Odero two yards in Genoa had a total workforces of 2,900 and a overall surface of 110,000 square meters.[30]

The few references which can be found in Terni's records about the yards' activities make clear that Odero and Orlando invested to modernise and keep their yards up to date. For instance, in 1905, Orlando bought the rights for the use in Italy of the steam turbine designed by the Swiss company Escher Wyss.[31] HMS *Dreadnought* had pioneered the introduction of turbines as replacement of triple-expansion engines in battleships, and the Italian yards (Ansaldo had secure the right to use Parson's design) rapidly responded to this development, by acquiring the new technology from established foreign producers.

Between 1904 and 1910 large investments were undertaken to increase the output of the steelworks. In 1904 the board approved the erection of a plant able to produce 3,000 tons a year of Krupp plates, which was later expanded to 5,000 tons.[32] This investment was followed by a new Martin-Siemens foundry and two 45 ton furnaces. In addition a 4,500 ton Davy press was installed to allow working larger forgings and, finally, a 16,000 HP rolling mill was also purchased.[33] Large investments were also made to increase the production of hydroelectric power: in 1911 Umbria was the first region in Italy in terms of installed power capacity per worker, a result which was entirely due to Terni.[34] This investment spree created a potential capacity which, however, was not fully utilised until the First World War. This was a recurrent issue for armaments firms: in order to achieve economies of scale they had to set up large works, works whose minimum efficient size grew with the development of military technology. However, because every firm was pursuing the same strategy, potential capacity was often a source of concern. In 1913 Terni produced 16,540 tons of steel, less than ten years before (and equal to a just 1,9% of the national output),[35] but virtually all the production was now devoted to armaments production as well as to supply yards with large forgings.

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30 Martorelli, 'Industria', 254, 256, 257.

31 AST, FT, b. 38,*Verbali*, 26 January 1905. The only publication in English on Escher Wyss is the commemorative volume B. Fehr, *Escher Wyss, 1805-1955. 150 years of development* (Zurich, 1950).

32 AST, FT, b. 38,*Verbali*, 16 June 1904.

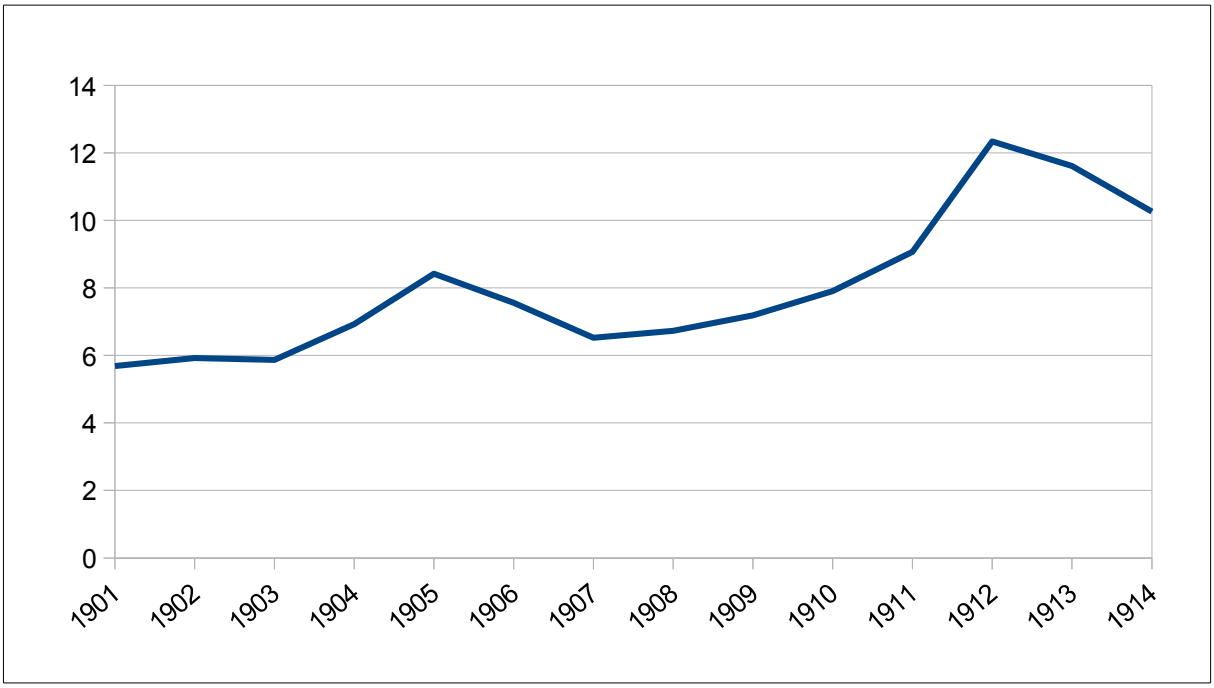
33 A description of the steelworks in this period is in *La Società degli Alti Forni, Fonderie ed Acciaierie di Terni ed i Cantieri Navali Fratelli Orlando & C. di Livorno, N. Odero & C. – Genova (Foce), N. Odero fu A. & C. – Sestri Ponente* (Roma, 1911).

34 V. Zamagni, *Industrilizzazione e Squilibri Regionali in Italia, Bilancio dell'Età Giolittiana* (Bologna, 1978), 92-93 and 228-229.

35 See G. Scagnetti, *La Siderurgia in Italia* (Roma, 1923)., 215-238, and Ilva, *Altiforni e Acciaieri d'Italia. 1897-1947* (Bergamo, 1948), 352-353.

Terni's final years results are shown in figure 7.5. It is difficult to assess how accurate is the representation of the firm's activities provided by Terni's balance sheets. Changes in the level of depreciations and other accounting practices were certainly used to smooth the level profits and to allow the distribution of dividends. The surge of profits in 1904-5 is connected with stock exchange operations carried on by Prina, whereas Terni's increased profitability from 1908-09 onward was a consequence of the increasing Italian naval budget.

Figure 7.5: Terni's final year results (in millions of current Lire):



Source: AST, Fondo Terni, *Relazioni dell'Assemblea degli Azionisti*, various years.

With the formal purchase of Odero and Orlando yards, Terni was one step away from being able to manufacture all the military hardware required for building a warship. Only the capacity to make guns was still lacking. To rapidly enter into artillery production, Terni could either purchase an already functioning gun making plant, or erect a new plant with the help of an established producer willing to offer its technical expertise. In the first case, the only possible target in Italy was Pozzuoli. In the second case, the difficulty was to find a suitable and willing partner. Terni's management had already thought about venturing into gun making some years before: in 1901 Terni discussed with Schneider the possibility of setting up a plant for gun making.[36] The fact that

36 AST, FT, *Verbali*, b. 37, 12 December 1901.

Schneider had provided Terni with technical support in the 1880s probably explains why Terni initially turned to it for assistance. Because of the scant records, it is impossible to say how serious were the overtures made by Terni, though.

The following year Terni's managers met with Armstrong's representatives to discuss a possible agreement about Pozzuoli. Armstrong, as it will be explained below, was looking for a way to increase the sales of its Italian branch. Terni offered to purchase half of the plant.[37] Once again, however, no agreement was reached. Armstrong was at the same time negotiating a joint acquisition of Ansaldo with Ferdinando Maria Perrone. Even though in the end the Ansaldo-Armstrong combination did not offer the results hoped for by the two partners, it increased the pressure on Terni to find a way to enter into gun making: Terni feared that Ansaldo would gain privileged access to the only plant in Italy able to make large and medium sized naval guns. Terni's board was equally worried about the fact that Armstrong had erected "a Martin-Siemens furnace and a forge plant" in Pozzuoli. These investments meant that Pozzuoli might stop to exclusively rely on Terni for its steel.[38]

With the Ansaldo-Armstrong agreement removing the possibility of gaining control over Pozzuoli, Terni's only way to acquire gun making capabilities was to set up a new plant with the technical support of an established producer. Terni finally succeeded in 1905 when Terni reached an agreement with Vickers to create a new plant for the manufacture of artillery in Italy. At the meeting of 7 July 1905 the board discussed the project. The chairman (Prina) underlined how such a step represented "the last part of the vast programme outlined by the board". Such a development occurred after "several attempts had been made by the firm's subsequent boards to arrive to an understanding with Armstrong." Orlando presented to his fellow directors the scheme of the agreement. Terni and Vickers were to create a new firm, the Vickers-Terni Società Italiana di Artiglierie e Armamenti, with an initial capital of 2,500,000 Lire.[39] The aim of the new firm was to "erect a plant based on the most modern principles for the manufacture of naval and land artillery based on the patents owned by Vickers and Terni."[40] Shares of the new company were subscribed by Terni, Vickers, the Orlando and Odero yards as well as Attilio Odero and Giuseppe Orlando personally. The board of the new company had an Italian majority. Albert Vickers was its chairman. Vickers controlled a minority stake in the new firm (it contributed 22.5% of the initial capital), but

37 AST, FT, id, 30 August 1902.
38 Id., b.38, 21 March 1904.
39 L. Segreto, 'More trouble than profit: Vickers' investments in Italy 1906-39', *Business History* 27 (1985), 316-337.
40 AST, FT, *Verbali*, b. 38, 7 August 1905.

it offered what Terni coveted more: technical know-how. Vickers supplied the new firm with drawings, patents and training opportunities in Britain for technicians and engineers. Moreover, Vickers received 10% of the firm's annual profits as a royalty in addition to its share of dividends. Terni, by contrast, provided the majority of the capital, gun forgings at discounted prices, and the unquantifiable, but crucial contacts with the Italian military hierarchy. Despite Vickers controlled only a minority stake, it is likely that its name was put first in the name of the new firm to capitalise on a brand which was well known in the armaments industry.

The partners decided to erect a gun plant in Spezia. Until 1908, bureaucratic problems delayed the construction.[41] Erection of the works took five years: in 1911 Orlando could inform the fellow directors that "the great Vickers-Terni plant in Spezia was nearly finished",[42] and in 1912 the first guns were completed.[43] Vickers-Terni faced now the problem of recruiting enough skilled workers: it was difficult, in fact, "to find serious and capable mechanics. Vickers-Terni had hired many of them from the Leghorn yard [of Orlando] and hopes to receive more of them from Odero and Terni".[44] The costs of erecting the plant increased significantly in the course of the years: during a meeting of Terni's board in late 1909, the capital of Vickers-Terni was raised to 5,000,000, 72% of the increase being covered by Terni and its directors.[45] Other increases followed in the subsequent years; the new capital was used to a large extent to finance the expansion of the works (Figure 7.6). The capital infused in Vickers-Terni came in the majority from the Italian shareholders. It is not by chance that the largest injections occurred after 1911, when the Italian naval budget started to expand at a very rapid pace and the advances paid by the government to the various firms belonging to the Terni group were partially used to finance the expansion of Vickers-Terni.

Despite the delay in the erection of the plant, Vickers-Terni started to receive orders from the navy already in 1910, the most important being that for the thirteen 305 mm guns for the *Andrea Doria*. The navy was keen on increasing the number of potential suppliers of guns on which it could rely, however, because the plant was not yet ready, production was carried out in Britain by Vickers (thus it is doubtful that Vickers pushed for a rapid completion of the Spezia plant).[46]

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41 Id., 24 March 1908.
42 Id, *Verbali*, b. 40, 19 January 1911.
43 O. Calamai, *Annuario della Marina Mercantile e delle Industrie Navali in Italia* (Genova, 1912), 305-7, offers a description of the works.
44 Id., 27 April 1911.
45 AST, FT, *Verbali del consiglio d'amministrazione*, b. 39, 12 October 1909.
46 Segreto, *Troubles*, 320.

Figure 7.6: Vickers-Terni capital and assets, 1909-1914 (in current Lire).

Year	Capital	Value of works
1909	2,500,000	1,000,000
1910	5,000,000	2,100,000
1911	5,000,000	10,600,000
1912	7,500,000	14,000,000
1913	12,500,000	17,300,000
1914	15,000,000	18,100,000

Source: Archivio delle Società Commerciali, Tribunale di Roma, f. 262/08, quoted in Doria, *Investimenti e Sviluppo*, 539.

In 1912 Vickers-Terni received an order from for field artillery the War ministry, the first significant order that the Army awarded to an Italian private firm since the 1860s. Until that moment, the Army had either relied on its arsenals or on purchases abroad, as in 1906, when the Army bought field ordnance from Krupp.[47] The Krupp field artillery, however, was not regarded as fully satisfactory and the Army started to plan for its replacement.[48] In 1912 a consortium of Italian firms formed around Vickers-Terni won the contract for the construction in Italy of a new model of field artillery based on a design developed by colonel Deport for the French Army.[49] Once again, Italian firms had to rely on foreign know-how and expertise in order to produce competitive military hardware. The production of the new guns suffered from conspicuous delays, probably because it overstretched Vickers-Terni's resources and internal capacities, and because of the difficulty of coordinating the activities of the firms involved. The guns started to be delivered only in 1914, on the eve of the war.[50]

Armstrong Pozzuoli

On 21 February 1900 Armstrong's directors met for a “special meeting” to “consider the present situation of the Pozzuoli works”, the first significant reference to Pozzuoli which appears in

47 G. Rochat and G. Massobrio, *Breve Storia dell'Esercito Italiano dal 1861 al 1943* (Torino, 1978),109, and F. Cappellano, *Le Artiglierie del Regio Esercito nella Seconda Guerra Mondiale* (Parma, 1998), 85.
48 C. Montù, *Storia dell'Artiglieria Italiana*, vol. 7 (Rome, 1941), 1358.
49 The Piedmontese entrepreneur Dante Ferraris played a key role in organising the consortium for the manufacture of the Déport gun, E. Orsolini, ‘Ferraris, Dante’, *DBI*.
50 Ferrari, *Verso la Guerra*, 203-4.

the minutes of the board since the creation of the Armstrong Pozzuoli company in 1896.

> The question of providing Pozzuoli with work has been a very serious responsibility during the last few years. Prospects of orders have, at all times, been uncertain, and periods of slackness and consequent discharge of workmen have been experienced.[51]

Armstrong directors admitted that a recent order of approximately 9 million Lire (£360,000) had improved the short term position of the company, reducing the need to find an immediate solution.[52] In addition, it was recognised that the management carefully run the plant, and that the production was of good quality. Problems lay somewhere else:

> [T]he future prospect of Pozzuoli must be considered as gravely uncertain. After its first establishment it has never commanded the active support of the government, except of the Minister of the Navy, partly because more strictly national competitors have sprung up and partly because we ourselves have not perhaps developed Pozzuoli so fully as the government hoped.
>
> From the period of their completion – about eight years – the works at Pozzuoli have remained practically stationary. Every other department of our works has been enormously extended, but we have hesitated to pursue any progressive policy at Pozzuoli through a feeling of uncertainty as to a consistent support of the government.
>
> When Pozzuoli was started there was some idea of our eventually constructing a shipbuilding yard, and plant for making ammunition, but these projects have not been carried out: the place remains entirely dependent on outside sources for its guns steel, and we do not make shells or ammunition. We have, in fact, from one cause or another pursued a half hearted policy with regard to Pozzuoli, looking upon it as a place in which we have sunk a great deal of money without much certain hope of return, and feeling a decided disinclination to embark any further capital in it.

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51 This and the following quotations come from T&W 130/1266, *Minutes of the meeting of the Board of Directors*, 21 February 1900.

52 Considering the timing, it is likely that the order refers to the guns of one of the *Garibaldi*-class cruiser.

This paragraph underlines the various Pozzuoli suffered from. First of all, the limited demand for guns: Pozzuoli was built at the peak of the Italian naval expenditures, but when the plant entered production the Italian naval budget started to decline, disappointing Armstrong's managers hopes of a thriving business. The ordnance plants in the arsenals of Spezia, Venice and Naples did were not serious competitor: altogether they could manufacture 3 203 mm guns every two years, 18 76 mm guns a year, plus a few dozens of 47 mm guns.[53] Considering that, for example, a cruiser of the *Garibaldi*-class was armed with 1 254 mm gun, 2 203 mm guns, 14 152 mm guns, 10 76 mm guns and 6 47 mm guns, or that the pre-dreadnought battleship *Vittorio Emanuele* (laid down in 1901) was equipped with 2 305 mm guns, 12 203 mm guns, 16 76 mm guns and 10 47 mm guns, it is evident that it was not competition from the arsenal plants which Pozzuoli had to fear. In addition, the growing importance given to large calibre artillery favoured Pozzuoli, which could manufacture 254 mm and 305 mm guns, whereas arsenals were not equipped to do that. The crux of the problem was that the orders received from the Italian Navy were not enough to saturate the potential capacity of Pozzuoli. This issue was magnified by the fact that the Italian Army, a potential large customer, did not buy from Pozzuoli.

The second problem identified was the lack of investments. Data on investments presented in chapter V pointed to a substantially flat trend after the plant was set up. The decision of reducing investments was a rational one in the short term: it was better to employ resources where the returns were higher, that is in Britain, rather than in Italy. In the medium-long term, however, underinvestment meant that the technological leadership in the Italian market could no longer be taken for granted, the productivity of the works stagnated and that it became increasingly difficult to attract foreign orders to Pozzuoli to counterbalance the weak domestic demand.

Pozzuoli suffered also from the fact that it could manufacture only guns.[54] The strategy of combining various armaments productions that had worked so well for Elswick was not replicated in Italy. To create a steel plant or a shipyard would have represented a huge expenditure with uncertain returns. Moreover, no Italian company before the early 1900s had embarked on such a strategy. Recently, however, the competition had become fiercer:

> Other establishments, concluding that Elswick will never pursue any vigorous expansive policy in Italy, have continuously extended their own works.

53 Inchiesta sulla Marina, *Relazione Finale,* vol. 2, *Relazioni Speciali*, 180-183.

54 Despite the fact that no proper shipbuilding activities was ever carried on there, the plant was known as “Cantiere Armstrong” (Armstrong's shipyard).

> Thus [the directors of] Ansaldo of Genoa have last year erected steel works, have tendered to the government for the forgings for the field guns, and say they will make guns outright if the government wish. Terni is making shells and has decided to make guns. It has refused already to supply us with forgings for shell which we are anxious to make, and may at any time refuse to supply us with gun steel. In that case the government will not allow us to use Elswick steel, because they can not do so in face of the country. It is important to note that we have hitherto not been in the position to make the ammunition for any of the armaments we have manufactured at Pozzuoli, and have therefore entirely lost the large profits to be made on such orders.

The threat that competitors could undermine Armstrong's monopolistic position in naval ordnance still laid in the future: in 1900 Italian firms lacked the experience and skills required to assemble guns of the same quality that Armstrong could offer. However, despite its technological competitive advantage, Armstrong could find itself in a difficult situation if Terni, its unique supplier of steel, would enter into ordnance making. The directors also emphasised an additional weakness of Pozzuoli:

> The fact of Pozzuoli not being an Italian firm has been always raised as an obstacle to placing orders with us and the growth of the national sentiment in Italy makes it continually more difficult for any ministry to give large orders to what is rightly or wrongly considered a foreign firm. This difficulty has recently become more accentuated, and the Minister of Marine has been practically forced to give his support to a combination of Italian firms. The ministry suggested that the combination should approach us with a view to including [Pozzuoli] in the scheme.
>
> It would seem that there are three decisions possible:
>
> a) join the combination;
>
> b) to ourselves vigorously expand Pozzuoli at a probable cost of ... [no amount is written in the minutes];
>
> c) to let matters go on as they are.
>
> In the last case we run a grave risk of being gradually edged out by more active

competitors.

It is evident that all the three options were unsatisfactory. Because in 1900 the conditions of the Italian armaments market gave no sign to improve in the short term, the third option did not seemed practical. The second was equally unacceptable: the combination the directors refer to was a projected agreement between the Italian companies Florio (a family concern involved especially in shipping)[55] and Hawthorn-Guppy and the French firm Schneider aiming at setting up a naval yard.[56] The idea of participating in such a project – which never materialised – was hardly attractive for Armstrong: the two Italian companies were small and their yards on the gulf of Naples were tens of kilometres away from Pozzuoli. At the same time, Schneider was an uncomfortable partner because it was a major rival in the international markets. Armstrong was in danger of providing the joint-venture with a valuable asset – the gun manufacturing plant – while receiving in exchange only a minority participation. The best solution did appear to lie in an agreement with an Italian partner, a link which could soft the uncomfortable foreign identity of Pozzuoli. At the same time, however, Armstrong's directors wanted to preserve full control over the plant which was, strategically, if not economically, a crucial asset, being the only company able to make large naval guns in Italy.

The first move of the board was that "authority should be given to Sir Andrew Noble to commence negotiations with the Minister of the Navy for the acquiring of the arsenal of Naples."[57] By 1900, the Italian Navy had decided to reduce the number of arsenals it owned, and to focus its investments on Spezia and Taranto. The arsenal in Naples, small and located in the city centre, represented a financial burden for the government, which wanted to "privatise" it. Armstrong then approached the Minister with a proposal:

> We understand that your Excellency's government has under its consideration the re-organization of the Royal Italian Arsenals, and that in the scheme of rearrangement it is contemplated to entrust the Neapolitan Arsenal to private management. If it is so, we shall be glad if your Excellency will allow us to make formal application for the concession. We trust that in making this

55 R. Candela, *I Florio* (Palermo, 1986), and id., *L'Economia dei Florio, una Famiglia di Imprenditori Borghesi nell'800* (Palermo, 1991).
56 T&W, 130/1266, *Minutes*, 21 February 1900.
57 Id., 25 April 1900.

> application it is unnecessary for us to make mention of the position of our firm, or of those intimate relations which have so long existed between your Excellency's government and ourselves. We will therefore confine ourselves to saying that in asking for this concession we do not seek any great profit for ourselves, but we wish to extend our operations in Italy, and to draw closer the bonds between the Italian government and our firm.[58]

The firm's assertion to be interested more in deepening the link with the government than in profits was rhetoric, but perhaps not completely insincere: by obtaining the management of the arsenal, Armstrong could expanded its activities in Italy to shipbuilding and other productions, increasing its chances to gain additional orders from the Navy. The following months were devoted to this project: first of all Armstrong secured the co-operation of three Italian firms based in Naples – Hawthorn-Guppy, Pattison, and Carmine de Luca – to make the deal more palatable to the public opinion.[59] Then, it put pressure on the government by informing that without new orders Pozzuoli could not avoid "discharge of workmen and attendant excitement and riots."[60] However, the Ministry and Armstrong did not reach an agreement on the sales of the arsenal. Armstrong wanted the Ministry to pledge to provide the arsenal with enough work to keep it busy. If this was impossible, the government was to cover the salary of the workmen and the losses of the company. The government refused to accept such a provision which, while favouring Armstrong in comparison with all the other firms working for the Navy, would not have reduced the Navy's costs. The board was informed that its tender had been refused.[61]

After this failure, Armstrong took two important decision in 1902. First, it decided to reduce its dependence on Terni by equipping Pozzuoli with steel works.[62] Second, he joined Ferdinando Maria Perrone in acquiring an interest in Ansaldo. The agreement with Perrone is analysed in details below, in the paragraph which dealing with Ansaldo; here it is discussed only in reference to the history of Pozzuoli. Pozzuoli was not part of the agreement with Perrone. Apparently this was an illogical move: Armstrong had acquired a large share of Ansaldo exactly to gain a sure outlet for Pozzuoli's guns and a merger of Ansaldo and Pozzuoli would have facilitated that. It seems plausible to speculate, however, that Armstrong did want to preserve the control of Pozzuoli not

58 ACS, Fondo Marina Militare, *Gabinetto* (1893-1910), b. 6, 19 April 1900
59 Id., 2 June 1900.
60 T&W, 130/1266, *Minutes*, 22 November 1900.
61 Id.
62 Id, 28 May 1902.

because of the profits it produced (which, despite the lack of data, seem to have been in that moment limited), but because – exactly as Terni for armour plates – Pozzuoli enjoyed a *de facto* monopoly in naval artillery. If Pozzuoli was too strongly connected with a certain firm, or group, this fact could generate the creation by rival Italian armaments firms of another artillery plant, which inevitably would eat into Pozzuoli's market share, as in fact happened later with Vickers-Terni.

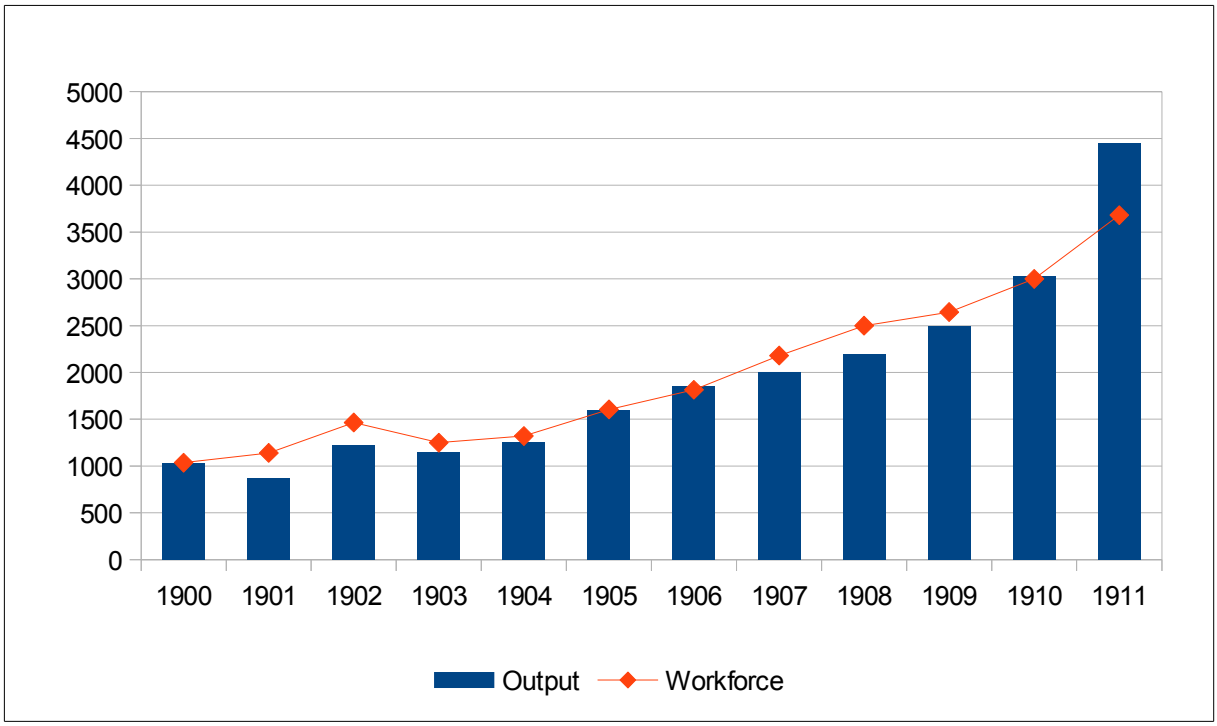
Pozzuoli seldom appeared in Armstrong's records after in 1908 Armstrong ended in all but name its involvement with Ansaldo. The only source which provide substantial information about Pozzuoli's activities in the years up to the First World War is the commemorative volume published by the Armstrong Pozzuoli company in 1912 to celebrate the fifteenth anniversary of the establishment of the Armstrong Pozzuoli.[63] Pozzuoli's fortunes started to improve from 1905-6 onwards, as output and workforce increased thanks to the rising naval budget (Figure 7.7). Between 1904 and 1911 Pozzuoli more than doubled its employees, from less than 1,500 to around 3,700. At the same time, production quadrupled, arriving in 1911 to exceed 4,000 tons of ordnance.

The decision to set up steel works had been especially fortunate because it had solved one of the major problems which had previously affected Pozzuoli:

> The most important expansion has been the creation a grandiose plant for making all the required metals, steel, pig iron and bronze, and for their processing, melting and forging … While before the firm had to supply itself from other companies for the majority of the semi-worked materials … now Armstrong exclusively buy raw materials in the market.[64]

63 *Lo* S*tabilimento Armstrong di Pozzuoli dal 1896 al 1911* (Bergamo, 1911).
64 *Stabilimento Armstrong*, 7-8.

Figure 7.7: Pozzuoli's workforce and output (in tons), 1900-1911.

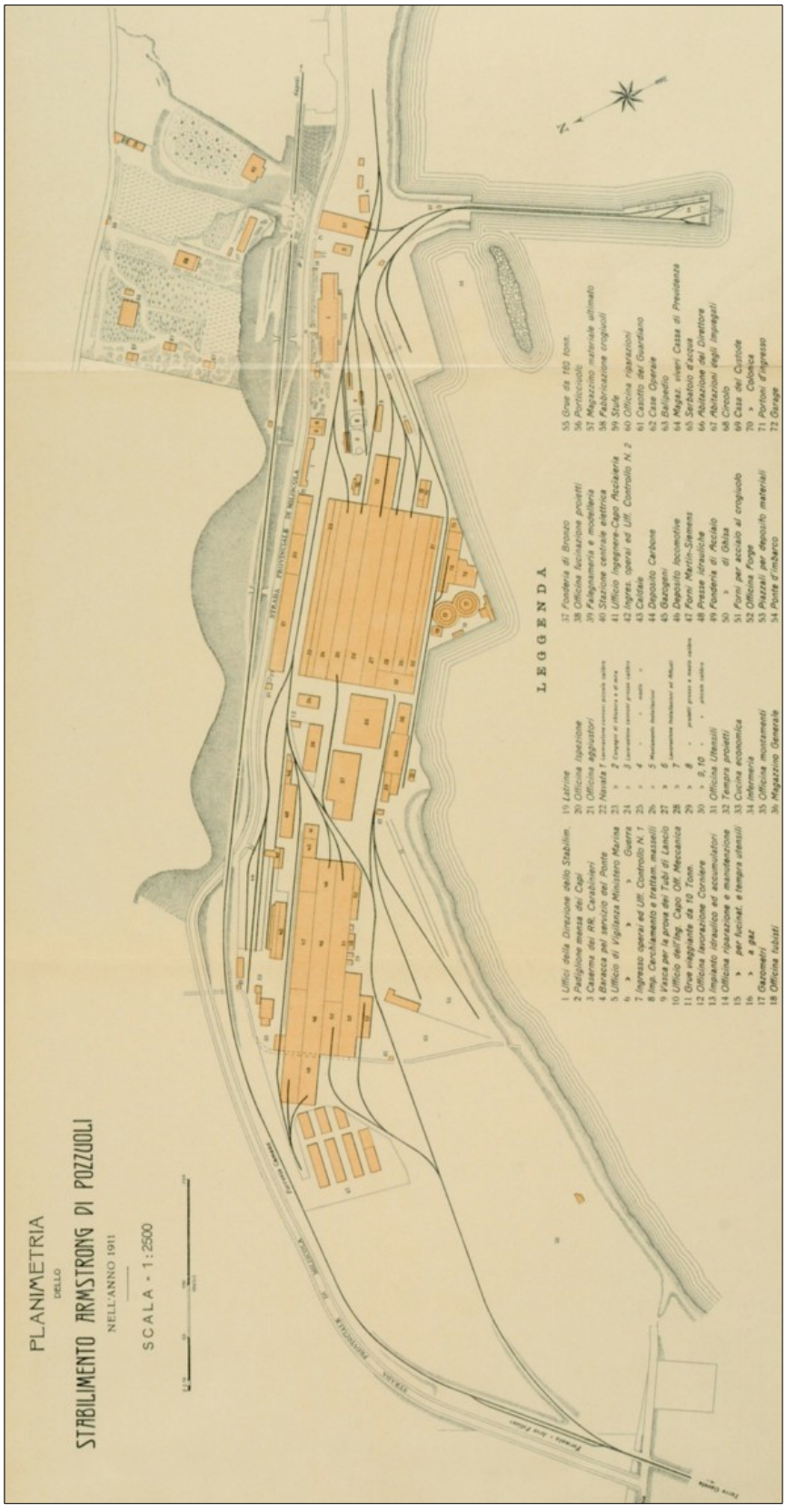


Source: *Stabilimento Armstrong*, 145 and 173.

The steel plant was equipped with 2 10 ton and 3 30 ton Martin-Siemens furnaces.[65] Pozzuoli could also make the crucible steel used for special components and tools. In addition, a 4,000 ton press to forge the steel ingots used for gun making had been implanted.[66] While the lack of data makes it impossible to quantify the resources used to finance these investments, by surveying the map of the works which appears in the 1912 commemorative volume (figure 7.8) it is possible to assess their results: in 1911 the gun making plant covered an area of around 17,600 square meters (it is the large building at the centre of the map), while the metal works covered an area of little more than 10,000 square meters (it is the other large building at the west of the gun shop). The plant was served by several kilometres of tracks and a 160 ton crane at the top end of the pier allowed embarking the finished guns. The result of these investments was that, by 1911, the capital value of Pozzuoli was assessed by Armstrong's management as around 1 million pounds.[67]

65 Scagnetti, *Siderurgia*, 197, reports the presence of four Martin-Siemens furnaces in 1913, while the 1912 official volume describes five Martin-Siemens furnaces. It seems more likely that Scagnetti made a mistake rather than that one of the furnaces being dismantled in the course of 1912.
66 *Stabilimento Armstrong*, 15.
67 T&W, 130/7746, 13 November 1911.

Figure 7.8: Plan of Armstrong Pozzuoli, 1911.



Source: *Stabilimento Armstrong*, figure out of text.

Ansaldo

In 1903 Ferdinando Maria Perrone with the substantial help of Armstrong purchased Ansaldo from the Bombrini family. Since the late 1890s Perrone had become the the most important foreign agent of the company. This had been just the last turn in his eventful life. Born in 1847 from a servant in the royal palace in Turin, Perrone had twice fought in his youth with Garibaldi and he had been involved in various murky affairs.[68] He later managed to secure a position as administrator of agricultural estates in the Padana Valley until, in 1885 he moved to Argentina. Here Perrone became an important figure inside the Italian community, developing contacts with journalists, bankers and politicians of the ruling *criollo* élite. He also started several economic activities which made him much wealthier than he was before moving to South America.[69]

Perrone became involved with Ansaldo in 1894, thanks to his brother-in-law, Antonio Omati, the managing director of Ansaldo's mechanical plant.[70] Perrone rapidly established himself as the driving force behind the plan to conquer new markets for Ansaldo's vessels. Using his contacts, Perrone was able to convince the Argentina government to order four *Garibaldi*-class cruisers in 1895-96 (two built by Ansaldo and two by Orlando), followed by other two (both built by Ansaldo) in 1901-02 which Argentina sold to Japan before they were completed and participated to the Russo-Japanese War. Perrone's skills were not that of the engineer: he had neither technical education, nor he displayed any strong interest in mechanics. By contrast, Perrone was good at rapidly sizing favourable circumstances to exploit his network of contacts (such as the Argentine on-off president, general Julio Roca) to create business opportunities.[71] As Paride Rugafiori states: "the non-industrial Perrone … had clear in mind the need for public relations activities."[72] These skills, which were decisive in his early business carrier as Ansaldo's chief salesman, were, however, much less useful later on, when he found himself at the helm of the firm.

The success in Argentina was followed by the sale of two more cruisers to Spain.[73] In 1901

68 P. Rugafiori, *Ferdinando Maria Perrone* (Torino, 1992), 1-5. In 1869 the young "paperhanger" Ferdinando was sentenced few months in prison for fraud and assault.

69 Id., 57-63. On the economic grow of Argentina in the late 1890s, see A. Ferrer, *La Economia Argentina. Las Etapas de sur Desarollo y Problema Actuales* (Buenos Aires, 1987).

70 The correspondence between Ansaldo and Perrone, some of them ciphered, is in AFA, FP, SSN b. 30.

71 Perrone's attempt to gain the favour of Crispi, the Italian prime minister in 1893-96, was less fortunate: Perrone "presented" Crispi with 150,000 Lire to help him to repay some personal debts. Such a donation became public when Crispi ended involved in a trial for peculation which later resulted into a parliamentary investigation. Perrone risked, once again, to face trial. See C. Duggan, *Francesco Crispi 1818-1901. From Nation to Nationalism* (Oxford, 2002), 717-18, and, for a contemporary evaluation of the events, D. Farini, *Diario di Fine Secolo*, vol. 2 (Roma, 1961), *passim*.

72 Rugafiori, *Perrone*, 83.

73 AFA, FP, SSM ter b. 97. The order for the second one was later cancelled.

Perrone, now back to Italy, was nominated Ansaldo's general director for foreign markets, and the subsequent year he acquired a 1/18 of the capital of the firm for 600,000 Lire. In 1903, Perrone approached Armstrong about the possibility to jointly acquire the control of Ansaldo by purchasing a majority interest in the firm. Perrone had first meet Armstrong's representatives when Pozzuoli was awarded the contract for the guns for the *Garibaldi* cruisers. Albini, who was a director of both Armstrong and Armstrong-Pozzuoli, played a key role in this negotiation.[74] Elswick set up a sub-committee to investigate Perrone's proposal which arrived while Armstrong was trying to find a way to reinforce Pozzuoli's position inside the Italian market. The special sub-committee reported to the directors that:

> The firms of Messrs Ansaldo, shipbuilders and engineers of Genoa, consists of three partners, two brothers Bombrini and Mr Perrone. Mr Perrone has a large interest and the opportunity now presents itself of buying out the Messrs Bombrini. The present proposal is that we should find half the capital for Mr Perrone to effect this purpose. The purchase value is stated at 18 million Lire [£720,000] and our share would be one half [£360,000]. The business would then be placed before the Italian public with a capital of 25 million Lire [£1,000,000]. It is thought that the shares would be readily taken up, and the Credito Italiano – an Italian bank – would be willing to underwrite shares to the amount of 6 million Lire.[75]

To define Perrone's interest "large" was an overstatement (he owned only 5.5% of the firm), but there is no doubt that he was the driving force behind the project. One of the attractions of the plan for both Perrone and Armstrong was that it could provide a solution for the problem of importing semi-finished and finished products from Britain: a company in which Italian investors owned at least half of shares could hardly be labelled as "foreign". Therefore it could more easily buy from abroad crucial components, freeing Ansaldo from the need to rely on costly Italian hardware. As the Elswick's directors stressed:

> A possible difficulty in obtaining armour plate was discussed, Terni holding under the armour plate convention [presumably this refers to the agreements of

74 AFA, FP, Misc., b. 5/3-4.
75 T&W 130/1266, *Minutes*, 17 June 1903.

> the Harvery syndicate] a monopoly for the supply of armour plates in Italy. But it is thought probable that if we possessed a controlling interest in Ansaldo, we should be allowed to supply our own armour plates from Manchester.[76]

After some initial resistance, Perrone was able to convince the Bombrini brothers to agree to the sale to him and Ansaldo of the controlling interest in the firm.[77] The Bombrini were attracted by the price Perrone offered: they were less bullish about the possibility of additional large orders (while Perrone maintained ambitious plans) and they had large business interests outside Ansaldo – public works, real estate and other industrial ventures – in which they could reinvest the profit of the sale.[78]

In December 1903 the Società Anonima Italiana Gio. Ansaldo Armstrong & Co. was created with a capital of 3 million Lire, half of it paid by Armstrong, and the other half by Perrone, Albini and other Italian shareholders, among them the Bombrini.[79] The interest of the Credito Italiano did not materialise, though. Elswick appointed as directors Admiral Albini (who was elected chairman), John Falkner and John Noble; the Italian shareholders appointed Ferdinando Maria Perrone (who was the company's chief executive) and Carlo Bombrini.[80] The new company then bought for 18 million Lire all the works, patents, designs and other assets of the old Gio. Ansaldo Company. The Bombrini would receive 4,888,786 Lire immediately, plus 17 million in shares of the new company. Armstrong – after a due diligence of the assets of the company – subscribed half of the increase in capital of the new company.[81] Who, however, was to be at the helm of the company was clear: "The said Commendatore Perrone shall become and remain a managing director of the proposed Company for a term of five years from its incorporation, at a reasonable remuneration".[82]

The two new partners in Ansaldo, Armstrong and Perrone, had however diverging objectives. – a divergence which explains why the collaboration between them did not produce the results hoped, and why it was terminated in all but name after only four years. Perrone did not have the resource to acquire the control of Ansaldo by himself, he needed a parter, and Armstrong offered

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76 Id.
77 Rugafiori, *Perrone*, 139-140.
78 M. Calzavarini, 'Bombrini, Giovanni', *DBI*; G. Doria, *Investimenti e Sviluppo*, 664-665. A. M. Falchero, 'La Costruzione di un Gruppo Industriale Integrato', P. Hertner (ed.), *Storia dell'Ansaldo*. Vol. 3, *Dai Bombrini ai Perrone, 1903-1914* (Roma-Bari, 1996), 146-148.
79 AFA, FP, SSM bis, b. 2/1.
80 T&W130/1267, *Minutes*, 15 October 1903.
81 In AFA, FP, SSB, b.854/2 there are two copies – one in Italian, the other in English – of the memorandum of understanding between the three parts involved.
82 AFA, FP, SSMbis, 2/2.

its support. Perrone, however, wanted something more from Armstrong: British armaments manufacturers enjoyed a technological leadership in the sector and Perrone wanted Armstrong to help Ansaldo to gain a leading position in the armaments business by sharing with it technologies and designs and transferring sophisticate expertise and know-how. In addition Pozzuoli and Openshaw could supply, respectively, guns and armour plates at discounted prices, counterbalancing the advantages that Odero and Odero had gained from their control of Terni. At the same time, his personal experience had made Perrone conscious that foreign markets were crucial for the fortunes of Ansaldo, given the limited size of the domestic Italian market. Once again, Armstrong could help Ansaldo by making it its "junior partner" in tenders for foreign ships (especially in South America).

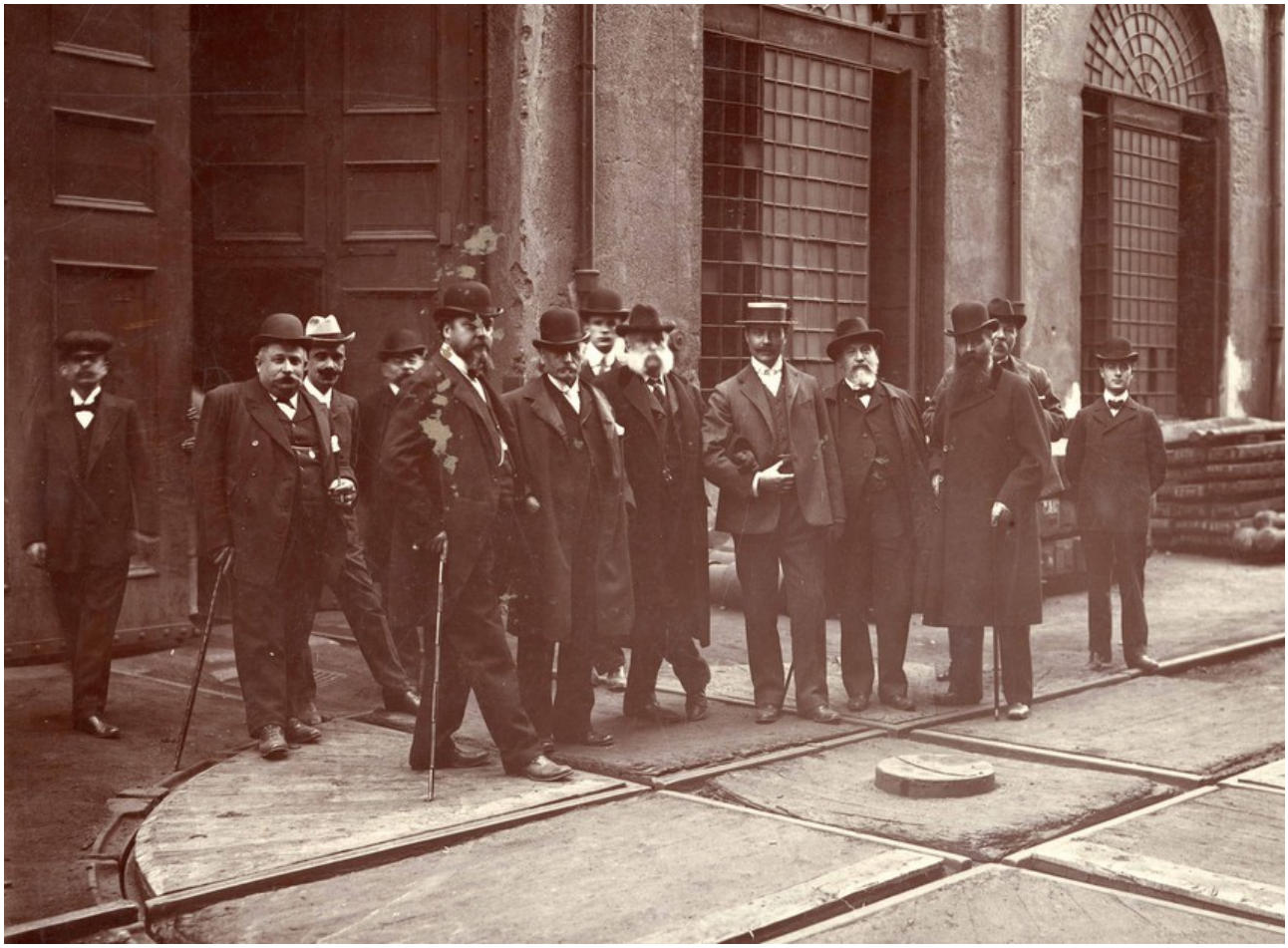
What Armstrong's board hoped to gain through its connection with Ansaldo was a more stable stream of orders for Pozzuoli, while, at same time, leaving the plant free to supply all the Italian yards. Time and again, the foreign ownership of Pozzuoli had been raised as problematic, given the strategic nature of its production. The Ansaldo Armstrong combination was a possible answer to this problem; in fact in the 1904 report to the shareholder the agreement was presented as a move undertook "in order to strengthen [Armstrong's] position at Pozzuoli and in other quarters".[83] A letter sent by Perrone on 24 September, 1903 summarised the realities behind the agreement:

> I formally bind myself, in name of the Gio. Ansaldo and Armstrong Company, to purchase exclusively from the Company Armstrong Pozzuoli or possibly from Elswick all the ordnances and ammunitions, and all the other items which could be needed, on top of all other suppliers, for all its works and orders from foreign countries as well as from Italy.
>
> Thus Given the communion of interests existing at the moment among the two companies and the excellent relationship which is the result of such a communion, the two companies promise each other assistance, using where needed one the foreign agents of the other to in order to protect and develop their own business.[84]

83 *Financial Times* 20 September 1904, p.2.
84 AFA, SSB b. 854/3.

It is evident that the first paragraph looked especially promising to Elswick, while the second encapsulated the hopes of Perrone who certainly was pleased that both Ansaldo Armstrong and Pozzuoli had the same chairman, Admiral Albini.

Figure 7.9: Ansaldo and Armstrong's managers visiting the mechanical plant of Ansaldo in 1904. Ferdinando Maria Perrone is the third man from the right. At the centre of the picture is Sir Andrew Noble, his arm in that of Pio Perrone.



Source: AFA.

The first years of the Ansaldo Armstrong were dominated by two crucial issues: to secure orders, and to expand the range of productions. Until 1909 orders coming from the Italian navy were relatively sparse: four sets of naval engines for capital ships, plus the fitting of the battleship *Napoli* built at Castellammare were the major contracts Ansaldo undertook. At the same time, to keep the yard active, Ansaldo built several destroyers for speculations, vessels which were

purchased by the Italian navy. All these works seem to have generated little profit for the firm.[85] Perrone, however, maintained high hope, for foreign orders: Ansaldo Armstrong participated to the competitions organised by Spain, Argentina, Russia, Brazil and Chile (to name the most relevant customers) to select the private firms to which order new dreadnoughts and cruisers.[86] The firm, however, did not gain any major contract, a striking comparison with the success of the 1895-1905 period.

Perrone acquired the control of Ansaldo Armstrong two years before naval warfare was revolutionised by the introduction of a cluster of new technologies (turbines, oil burning boilers, etc.) of which the dreadnought design represented the most visible aspect. Ansaldo, as well as Odero and Orlando, lost immediately much of the ground which they had conquered in the previous decades of incremental innovation and which had led them to so successfully export *Garibaldi* cruisers to various foreign countries. Suddenly larger, faster, more heavily armed and protected vessels became the norm and, as it is common in the case of the introduction of new technologies or design, the first movers, in this case the British armaments firms enjoyed a significant advantage; in fact before 1914 Armstrong and Vickers gained the majority of the orders for dreadnoughts built in private yards for foreign customers. The key reason why Ansaldo Armstrong (and the other Italian firms) saw a decline in foreign orders for large vessels was that it lacked the technical expertise required: Italian yards had to be enlarged to accommodate the kennels of the new dreadnoughts, they machinery modernised, licences for turbines acquired, etc. This was without considering the problem of the supply of guns and armour plates which were dominated in Italy by two monopolies, Pozzuoli and Terni. Other circumstances might also have played a role, such as the absence of contacts with powerful personalities inside governments and armed forces, and the fact that no Italian yard built a dreadnought until 1909 weakened their chance to acquire orders abroad. Despite his personal contacts, and his remarkable ability as salesman, Perrone had no chance to successfully compete with the major British armaments firms which could quote lower prices, guarantee shorter construction time and, moreover, collaborated among each other.

During this period, the only important foreign customer was the Ottoman Empire which awarded Ansaldo Armstrong the contract for modernising some units of the imperial fleet and, in addition, purchase nine torpedo boats.[87] What is more, the Turkish government signed an agreement

85 AFA, SSNB, b. 955. *Minutes of the Board*, 31 March 1908. The minutes are quite explicit on the fact that the profits of those years resulted from creative bookkeeping (negative or positive items were regularly put forward or backward, generous assumption about future payments were made, etc.).

86 M. Doria, *Ansaldo. L'Impresa e lo Stato* (Milano, 1989), 83-90.

87 Bagnasco and A. Rastelli, ‘Le costruzioni Navali Italiane per l'Estero’, special issue of *Rivista Marittima*, December

with Ansaldo Armstrong which gave the firm the management of the major arsenal of Istanbul, with the aim of transforming it into a modern establishment. The Turkish government, however, was an unreliable payer which took months to deposit any due instalment. Eventually the Libyan war ended a relationship which had generated plenty of correspondence, but meagre profits.[88] Ansaldo's position improved substantially after 1908-9, when the growing Italian naval budget provided the firm with a substantial stream of orders, the largest being that for the construction and the engines of the dreadnought *Giulio Cesare*.

Perrone was equally frustrated in his aim of increasing the range of Ansaldo's production or, at least, to obtain the material which Ansaldo did not produce at discounted prices. Already in 1905 Ansaldo's management planned to enlarge the steelworks so to make armour plates and break Terni's monopoly in this field. Until that moment, the steelworks had been a small plant whose main task was that of produce semi-finished goods for the mechanic plant.[89] An armour plant would have been a crucial step toward the creation of an integrated company, freeing Ansaldo from the need to purchase plates on the market. Albini took the matter to the attention of Noble, asking for Elswick's technical support. Noble replied that a plant of the kind of Openshaw, with a capacity of 3,500 tons of armour per annum would cost around £500,000 (12,5 million Lire).[90] The high price forced Perrone to delay this investment, which, at the same time, necessitated of the support of an experienced partner, considering the sophisticated nature of armour making. At the same time this project suffered from another limit: how would have been possible for Ansaldo to sell thousands of tons of armour a year when Terni was equally investing to increase its productive capacity to 5,000 tons of Krupp plates a year? Ansaldo's investment would have near doubled Italian output in a moment in which foreign orders were declining and the domestic demand still flat.

The relationship between Italian and the British shareholders soon deteriorated: the interests of the two groups were too distant to make possible an easy collaboration. Ansaldo wanted Armstrong to sell it armour plates and guns at discounted prices, while Noble offered only a reduction of 5-6 %.[91] The support of the Armstrong's board to the ambitious projects of Perrone of transforming Ansaldo into a fully integrated armaments company was, at most, lukewarm. Armstrong was happy to help Ansaldo as far as the Italian market was concerned, but, being a

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1991, 34.

88 A. F. Saba, 'L'Attività dell'Ansaldo nell'Impero Ottomano', P. Hertner (ed.), *Ansaldo*, 93-110; T. Row, *Il Nazionalismo Economico nell'Italia Liberale. L'Ansaldo, 1903-1921* (Bologna, 1997), 61-90.

89 M. Doria, 'Dal Progetto di Integrazione Verticale alle Ristrutturazioni dell'IRI: la Siderurgia Ansaldo (1900-1953)', *Annali della Fondazione Luigi Einaudi* 17 (1985), 411-453, details the evolution of Ansaldo's steel activities.

90 AFA, FP, SSM b. 7/3.

91 AFA, FP, SSM 7/1, 5 June 1905, and AFA, FP, SSNB 955.

dominant player in the international markets, it regarded as unwise to strength too much a company which, however smaller, could in the future erode Armstrong's market share. In this respect there is a relevant letter which Perrone wrote to Andrew Noble – which, even if undated, can be dated to the last months of 1906 – in which he lamented the fact the "since the combination, which was especially designed to help the expansion of all the activities of Ansaldo, the condition of the new company in reference to the freedom of production and action had worsened as a result of international illiberal industrial combinations."[92] Frustrated especially by the inability to obtain armourer plates, Perrone stated once again his desire to establish "a plant to manufacture the plates Ansaldo had hoped to obtain from its associate … in order to have a homogeneous and powerful organism whit which to contrast the actions of Vickers [and Terni]."[93] Perrone equally suggested that Ansaldo was willing to purchase Pozzuoli, but, once again, Armstrong rebuffed his overtures preferring to preserve full control over the plant which was finally going through a positive moment. Armstrong's attitude toward its Italian partner can be explained by the fact that it discounted the possibility that Terni and Ansaldo would autonomously enter into gun manufacturing: "The probability that both [i.e. Ansaldo and Terni] should start the same manufacture [i.e. gun making] is excluded because a madness cannot be supposed."[94] Armstrong believed that the Italian market was too small to support an enlargement of the artillery manufacturing capacity.

Under these circumstances, the collaboration between Perrone and Armstrong could not continue. In 1908, after Perrone's sons Mario and Pio inherited the control of the firm after the death of their father, Armstrong sold to them the majority of its shares. The final balance of the agreement with Armstrong was meagre: after five years of efforts, Ansaldo was still in the same position it had been in 1903: without autonomous gun making or armour plate manufacturing capacity. Mario and Pio initially adopted the strategy of arranging temporary *ad hoc* agreements with various suppliers of armour and guns so to be able to compete for foreign orders, although no order was secured. Ansaldo's archive conserve the many letters which the firm exchanged with practically all the major armaments companies: Cammell Laird (after having been temporally excluded from the list of Admiralty and War Office suppliers, the firm was especially keen on gaining foreign orders which could improve its results) and Skoda were contacted in 1908 in relation with a tender for Spain.[95] In

92 AFA, FP, SSB n.854/35.
93 Ibid.
94 AFA, FP, SSNB, 1082/11.
95 AFA, SSM n.5 f.17

1910, to compete for the construction of two Chilean dreadnoughts, Ansaldo contacted Italian (Terni and Pozzuoli) British (Vickers, C.O.W.), French (Schneider and Marrel Frères), and American (Bethlehem Steel) firms.[96]

The continuous inability to gain conspicuous foreign orders, compounded by the rising Italian naval budget, convinced Mario and Pio Perrone to change strategy and start focusing more on the development of internal capabilities by directly entering into gun and armour plate manufacturing. Terni was rapidly becoming able to manufacture all the components needed by a modern warship, and Pozzuoli was still under sole control of Armstrong which had no intention to share it with any partner. Establishing a systematic relationship with a foreign parter which could provide all the missing components at discounted price and in time, had proved a strategy difficult to implement, as the bitter experience with Armstrong had made clear.

The adoption of a strategy of vertical integration still left open the issue of how to acquire the technical know-how needed to make guns, gun mountings and armour plates. This problem was solved by entering into arrangements with foreign partners whose involvement, however, was strictly limited to a pure advisory role: the Perrone wanted to exercise full control over the firm's strategy.[97] In 1910 Ansaldo obtained the help of Schneider to set up a gun plant. This was a simple technical accord which involved no financial links.[98] A year later Pio Perrone could communicate to the board that Ansaldo had also solved the problem of armour plate manufacturing, thanks to a technical agreement with another French firm, Marrel.[99] Both these firms had no business in Italy, therefore they had no previous interests which could be threatened from the rise of Ansaldo and thus they were willing to provide the Italian company with their expertise in exchange for technical fees and royalties. Schneider, in addition, benefited from the fact that, when Ansaldo in 1911 gained orders for naval guns which it could not yet manufacture, the construction was diverted to it.[100]

The adoption of a vertical integration strategy meant that Ansaldo had to invest large resources. Ansaldo financed its investments in two ways: by retaining earning and by making use of

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96 The fruitless contacts between Ansaldo and American firms are described in F. Fasce, 'Strategie Imprenditoriali e Mercato Mondiale degli Armamenti: i Rapporti tra l'Ansaldo e la Siderurgia USA nel Primo Novecento', *Società e Storia* 38 (1987), 915-947.

97 This is also evident from the composition of Ansaldo's board: after the representatives of Armstrong resigned in 1908, Mario and Pio Perrone packed it with the managers of the firm and, in addition, convened it few and few times.

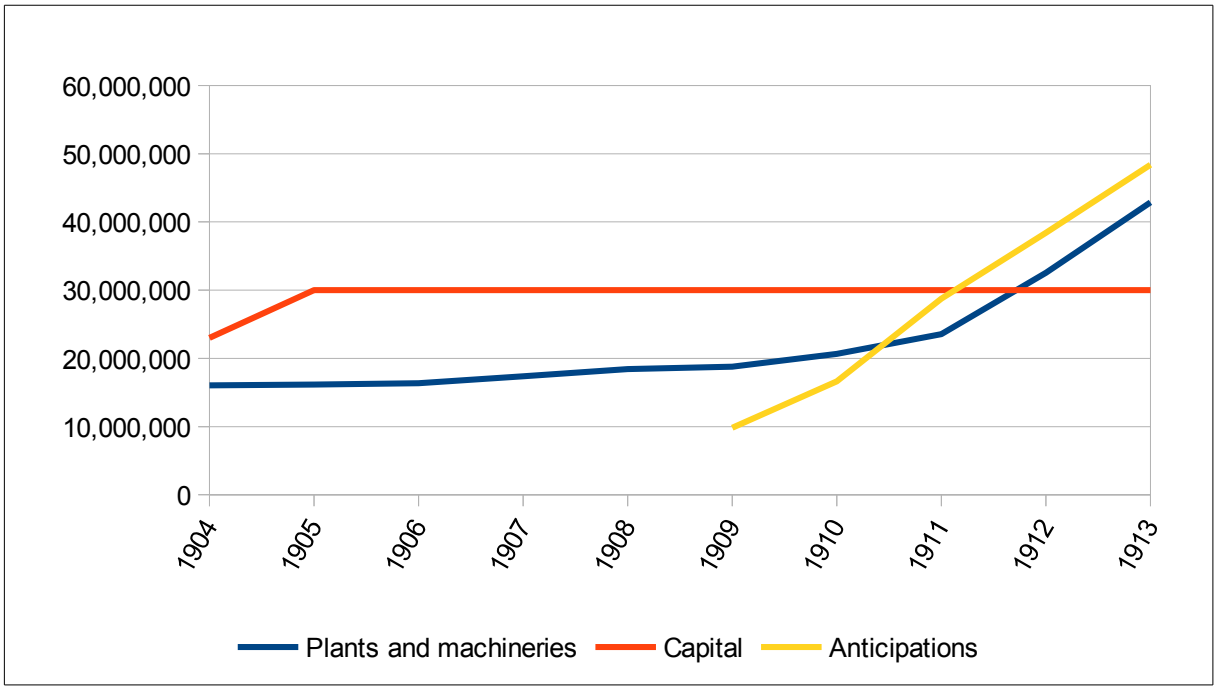
98 C. Beaud, 'Investissements et Profits du Groupe Multinational Schneider', *Histoire, Économie et Société* 7 (1988), 134.

99 AFA, FP, SSNB 955 and AFA, FP, SSR 81/3 for the agreement with Marrel. On this firm see M. S. Smith, *The Emergence of Modern Business Enterprise in France 1800-1930* (Cambridge, 2006), 188 and 195-196.

100 A. Curami, 'L'Ansaldo e l'Industria Bellica', *Italia Contemporanea* 195 (1994), 277-278.

the anticipations it received from the Italian government. A close look at the balance sheets point to how crucial the anticipations were. Between 1909 and 1913 (anticipations did not appear in the balance sheets before 1909) the evaluation of the firm's physical assets (plants and machineries) doubled, passing from a little more than 20 million Lire to more than 40 million Lire. Notwithstanding these numbers could have been affected from inflated assessments, the trend is too strong to be misinterpreted. Such large and fast growing investments, however, were not paid by increases of the firm's capital, which during all this period remained at 30 million Lire, the level of 1905. By contrast it was the anticipations which financed the expansions of Ansaldo's assets: the trend of investments, in fact, closely follow that of anticipations (Figure 7.10).

Figure 7.10: Assets and liabilities of Ansaldo, 1904-1913 (current Lire)

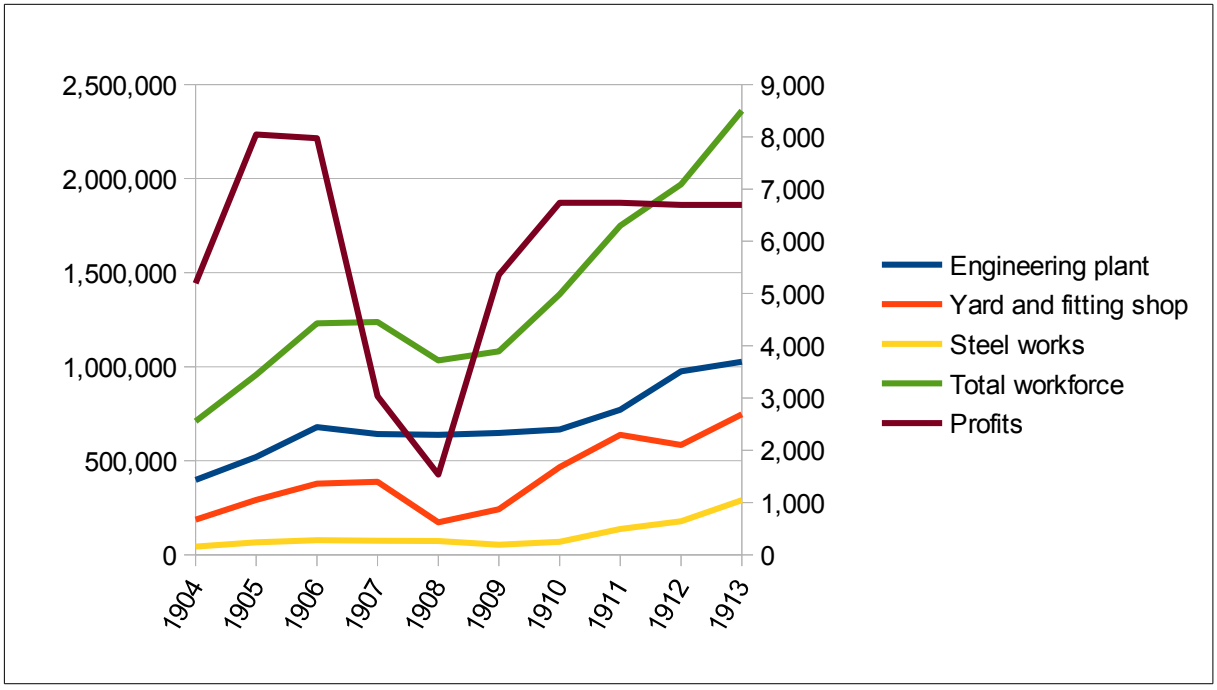


Source: AFA, FP, SSNB 955 and SSR 45.

The first years of Ansaldo Armstrong saw an increase of the workforce and of profits. The orders for the last two *Garibaldi* were keeping the yard busy. At the same time, also the engineering plant, whose main production were naval engines and boilers, increased its workforce. In 1906, however, the previous growth in employment reversed itself; in the years 1907-08 this was especially pronounced for naval shipbuilding and naval fitting, activities which were directly hit by the decline in the number of orders for warships. In contrary, mechanic production weathered much

better the negative moment thanks to the orders for engines coming from the Italian Navy. Profit, which between 1904 and 1906 had been over 1.5 million Lire a year, plummeted, and in 1907 and 1908 there would be no profit at all if the board had not authorized to postpone some costs to future exercise and to reduce the amount of resources appropriated for covering risks.

Figure 7.11: Ansaldo's workforce (right axis) and profit (in million of current Lire, left axis), 1904-1913.



Source: AFA, FP, SSR 388/5 for number of workers ("Total workforce" is obtained by also adding workers employed in divisions not reported in the figure); AFA, FP, SSNB 955 for profits.

Starting from 1909 Ansaldo's fortunes decisively improved. The workforce increased substantially, until in 1913 Ansaldo employed around 8,500 people. The expansion occurred in every department of the firm, with the steel works experiencing the largest increase in relative terms (400%) between 1910 and 1913: this was the result of the investments in armour and gun making, both production requiring steel as basic input. The two waves of expansion – 1904-06 and 1909-1913 – had, however, very different origins: before 1906 Ansaldo was chiefly occupied building warships for foreign governments; after 1908, in contrary, Ansaldo worked quite exclusively for the Italian armed forces, supplying the Navy with engines and a dreadnought. In the late 1900s profits equally returned to the pre-1907 level, a little less than 2 million Lire. From 1910 onward, however,

they remained flat. This was because a sizeable amount of the profits were used to self-finance the investments required to enlarge the steel works and set up the new gun making factory.

7.3 *Conclusions.*

In the years from 1900 to the First World War the Italian armament industry rapidly evolved. At the turn of the century both Terni and Pozzuoli enjoyed a de facto monopoly in, respectively, armour plates and large naval artillery. In 1914, by contrast, Ansaldo had joined Terni in armour plate production, and Vickers-Terni and Ansaldo both had set up gun making plants. Italian firms still had to rely on foreign technology and expertise to acquire the capability to manufacture the most sophisticated products.

Pozzuoli's evolution was partially different: at the turn of the century Armstrong had not yet achieved the results it expected when it had decided to invest there. Various reasons explain this: for years the Italian Navy's demand had been lower than initially expected, after the initial construction period the company had invested too little, and Pozzuoli was focused exclusively on producing artillery. Armstrong's first response was an alliance with Ansaldo, but also the agreement with the Perrone family did not produce satisfactory results, and Armstrong reverted to a stand-alone strategy for Pozzuoli., a strategy more suited to its quasi monopolistic position in naval artillery. This time, however, there was a crucial difference with the previous period: significant investment were made to increase and modernise the plant. The combination of new investments with the pre-eminence of large artillery in naval warfare magnified the competitive advantage of Pozzuoli: government arsenals were certainly not able to produce large guns and mountings. At the same time, private competitors were only slowly starting production: Vickers-Terni in 1912 and Ansaldo in 1914.

The cluster of technologies linked with the dreadnought design damaged Italian firms which, suddenly, lost much of the ground which they had gained since the 1880s. In fact, Italian companies enjoyed much more success on foreign markets in the period 1895-1905 then in later years, when it was the Italian military expenditure which principally sustained their activities. New technologies favoured the introduction of larger vessels with powerful guns and improved armour plates, warships which the Italian firms were at disadvantage to manufacture.

Both Terni and Ansaldo made use of alliances, joint-ventures and technical sharing agreements to acquire foreign know-how. At the same time, however, these agreements worked

only in few occasions because the interests of the various parts were seldom aligned: in an oligopolistic sector, incumbents did not desire to prop up potential rivals. This is why the Ansaldo-Armstrong alliance did not work, but the Vickers-Terni joint-venture functioned (Vickers had no previous interest in Italy, and the Odero-Terni-Orlando combination was less actively looking for foreign markets than Ansaldo).

It is questionable, however, if by 1913-14 the Italian armaments industry had achieved a stable configuration. The large investments made to take advantages of the growing Italian naval budget had led to a remarkable expansion of the industry's productive capacity. Technology had pushed up the minimum size at which plants for armour plates and ordnance could generate economies of scale. While Terni in the 1890s made around 2-3,000 tons of armour a year, in the 1900s the firm's capacity has risen to around 10,000 tons a year. In the early 1910s Ansaldo added 5-6,000 tons a year of additional potential production. Unsurprisingly, production capacity was not saturated until the country entered in war in 1915. Similarly, it is unlikely that Pozzuoli, Vickers-Terni and Ansaldo's gun plants would have all been able to prosper without the dramatically increased in the demand for ordnance.

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Chapter VIII

Conclusion

This thesis has offered an explanation of the rise of private armaments firms in Great Britain and Italy in the period from mid-19th century to 1914, and so has advanced the understanding of the growth of the armaments industry in the decades before the First World War, a period when armaments companies became major actors in most advanced economies. This development occurred in virtually all the major industrial countries before 1914. By adopting a comparative approach focused on Italy and Britain – countries economically, socially, politically and strategically very different one from the other – it has better highlighted the underlying common dynamics as well as the peculiarities characterising each experience.

The magnitude of the changes which occurred can be appreciated by comparing the armaments industries in Italy and Britain in the 1850s with those of 1914. In the 1850s there were no private firms manufacturing heavy military hardware in either country: market conditions and the state of technology limited the scope for private initiatives, while favouring government-owned arsenals and yards, whose output of was sufficient to meet the demand for armaments. Stagnant military technology limited the problem of technical obsolescence: guns and warships could be retained in service for decades, reducing the overall demand for armaments. Governments could enlist the help of private firms in case of protracted military engagements (as occurred in both Great Britain and France, for example, during the Napoleonic wars). As soon as hostilities ended, however, governments cancelled contracts with private firms and returned to relying exclusively on their traditional procurement channels.

By contrast, after six decades, in 1914, the private armaments industry had moved from being a non-existing industrial sector to become the crucial actor in military procurement. Companies such as Armstrong, Vickers, Ansaldo and Terni were indeed the key suppliers of advanced military goods to governments around the world. Arsenals and government-owned yards still produced guns and warships, but their output was not sufficient to satisfy the demand of the armed forces. In addition, government plants did not manufacture certain crucial components – such

as, for instance, armour plates and large-calibre naval guns (in the case of Italy) – which were exclusively supplied by the private sector.

Increasingly rapid innovations in military technology were crucial in revolutionising the armaments industry in this period. As pointed out in chapter I, the introduction of ironclads and rifled ordnance in the late 1850s radically changed naval warfare. This was not, however, a simple "one-off" technological change, but, on the contrary, it was the beginning of decades of sustained innovation in military technology. The fact that by the mid-19th century military technology had lagged behind civilian technology created room for rapid improvements, whose pace was accelerated from the 1880s onwards by the application to the armaments industry of many innovations developed in the steel and chemical industries.

Access to up-to-date technology started to be seen as a crucial factor, dramatically increasing the opportunity cost for governments of *not* fielding modern military hardware. At the same time, rapid technical innovation translated into a high rate of technical obsolescence which generated a constant demand for armaments. Guns and warships now usually had to be replaced after just a few years in order to keep pace with technology. Countries wishing to have an effective naval force had no option but to acquire advanced military goods, and to do so repeatedly. Government yards and arsenals, however, did not produce, or were not able to make, all the components required to build modern warships. This fact, and the constant demand for military hardware, generated unprecedented business opportunities. As a result, in the course of the years private armaments firms were able to acquire a dominant, if not outright monopolistic, position, in certain areas. For example, armour plates were routinely purchased from private suppliers from the 1850s onwards, because government were unwilling to expand arsenals' activities into steel making, and because private firms were able to satisfy the need for armour plates. Similarly, gun mountings for large guns were supplied by just a handful of private companies because their complexity made them difficult to manufacture.

The growth of private armaments companies was not a linear process, however. For instance, Armstrong, after the British government suddenly terminated its contract with the firm in 1863, did not receive another major order from it until the 1880s. In the course of the intervening years Armstrong exclusively relied on foreign customers. Likewise, British yards stopped being awarded large numbers of contracts after the Royal Dockyards had been modernised in course of the early 1860s. At the same time, Ansaldo's attempts to become a supplier of the Italian Navy were repeatedly frustrated in the 1860s and 1870s because of the insufficient amount of orders received, and the firm's incapacity to produce modern hardware. In general, what emerges from this thesis is

that the armaments industry in both Italy and Great Britain was very diverse and articulated: until the late 1890s, fragmentation still predominated, with different firms producing different goods, and many companies involved in both civil and military productions.

Staring from the 1880s, the relative position of arsenals and government yards towards private firms started to further deteriorate. In the course of that decade, both Italy and Britain markedly increased their naval spending. In addition to this, a new wave of technical innovation reshaped naval technology. Governments realised that the only way they had to rapidly escalate military production was to award contracts to private firms. Contracts which, however, were now not exclusively limited to hardware which government plants did not produce, but also covered those activities, such as shipbuilding, which government arsenals and yards did carry out. It was in this context that a second group of private firms, among which the most important were Vickers and Terni, ventured into armaments production. Thus, a combination of technological evolution (the introduction of breech-loading guns, steel vessels and slow-burning propellants) and specific historical events (foreign and domestic policy crisis in Italy and Great Britain) generated a new procurement system, one in which private firms played a very prominent role.

In the two decades before 1914, naval guns became bigger, gun mountings more sophisticated, armour plate more complex and warships larger and more expensive. This trend had an impact on the internal organisation of the armaments industry in both Italy and Great Britain: these technical developments, in fact, favoured the creation of highly capitalised and vertically integrated companies which could sustain the never-ending stream of investments needed to keep their works up-to-date: for example, the price of an armour making plant increased fourfold from the late 1860s to the late 1890s. Thus, all the major firms active in military production tried, more or less successfully, to consolidate themselves and increase their size by acquiring the capability to produce guns, armour plate, warships, etc. This was obtained either by means of mergers and acquisitions with other companies or by internal organic growth. The growing complexity of military technology, however, meant that it became impossible for armaments firms to use their military plants also for civilian productions. This explains why, for example, Vickers, John Brown, Cammell and Ansaldo moved from being firms with just a foot in military production to concentrating more and more of their investments and efforts into armaments manufacturing.

Also the relationship between private armaments firms and governments evolved in the course of the decades. A comparison between the British and Italian experiences of the early 1860s with that of the 1880s and 1890s provides evidence to generalize Volker Berghahm's insights about

the role that rapid increases in military spending had in the creation, and later preservation, of a private-based procurement system in Germany. In the 1860s governments drastically limited their dealings with private firms after they had modernised their own arsenals. The British government, for example, had no problem in stopping buying from Armstrong, even though this decision put the survival of the firm at risk. The government could do that not only because Woolwich manufactured artillery of similar quality, but also because of Elswick's still relatively limited size. Armstrong's fortunes, that is, could easily be ignored because the firm was quite small. By contrast, after private firms greatly expanded their operations in the course of the 1880s to respond to sudden increases in naval spending, governments found themselves in the position of being unable to drastically cut their involvement with the private sector. Orders could sometimes be limited and military spending momentarily cut, but the basics of the new procurement system remained unchanged: the private armaments industry had now acquired a dimension which made it simply too important a part of the economy to be deprived of orders. While it was easy to cut links with Elswick when it employed less than one thousand workers, it became impossible to do the same when it directly provided near twenty thousand jobs. Equally, the Italian Navy could not ignore that thousands of workers in Genoa, Leghorn and Naples who were dependent on contracts being awarded to private firms, as local politicians and city bureaucrats continued to stress in their endless request to the central government for additional orders.

The dynamics briefly summarised above explain why private armaments firms rose to prominence in all the major industrial economies before 1914. Although the final outcome was similar in both Italy and Great Britain, the experiences of the armaments industries in the two countries differed in various key aspects: the relationship between governments and private firms; the role played by financial institutions in supporting the growth of armaments firms; the impact and nature of technological innovations; and the level of competition and cooperation between private firms.

In Britain, the government exercised little influence over private firms' activities. It tried to convince several firms to enter armaments production and to undertake certain investments, but in general it avoided interfering with their activities, or directing their strategies. It left British firms free to sell their products to virtually every government willing to pay for them. For example, when Italy purchased from Elswick several 100 ton guns potentially able to overcome Malta's defence, the British government did not block the sale, but, instead, it purchased from Armstrong a few of the same guns to be deployed in Malta. Behind such a *laissez-faire* approach there was the idea that

it was actually in the interest of Britain, which boasted the largest and most modern armaments industry in the world, that the country's private armaments firms kept selling their wares abroad. In case of war, Britain could thus count on a modern and well-developed industry which could rapidly be mobilised.

By contrast, the Italian government, especially the Ministry of Marine under the leadership of Benedetto Brin in the 1880s, displayed a much more active and interventionist attitude. The chief reason motivating this different approach was that, for strategic and military reasons, the Italian government wanted to develop a domestic armaments industry in order to free the country from the need to import crucial hardware. The acquisition of a national armaments production capability was seen as part of the state-building process, an aim which could not be judged in purely economic terms. To achieve this end, the Italian Navy adopted various measures: it convinced Armstrong to create a branch in Italy by threatening to stop buying from it at a time when Italy was among Armstrong's major customers; it provided essential financial support for the establishment of Terni's steel plant by offering the firm large advances; in general, it favoured domestic firms, even thought their wares were more expensive. Such a policy was costly in the short-term, because the prices paid for products made in Italy were often higher than that of imported hardware and the Italian government proved to be a very accommodating customer, accepting delays and forfeiting penalties for late deliveries. However, it substantially achieved its long-term aim of fostering the development of a domestic armaments industry even though the Italian armaments industry did not enjoyed the same level of technological sophistication of the British one (more on this below). The approach adopted by Italy was, by and large, the same followed by other ‘second comers’ powers. Japan, for instance, also moved from importing entire warships (usually purchased from British yards) to investing large resources for the creation of a local industry able, thanks to links with foreign companies (again, in the majority British), to develop an autonomous capacity to produce modern, up-do-date military hardware.

It is evident from what has been discussed in this thesis that the relationships between governments and the armaments industry cannot be easily classified as one in which one part necessarily prevailed over the other. Certainly, as Trebilcock stressed in all his contributions, governments enjoyed much leverage over the activities of armaments firms which, eventually, were depending on their orders. However, the magnitude of this influence varied significantly between periods and among countries. The Italian case offers an interesting example of how looking at the government-business relationship as constant and immutable is misleading: in the 1880s, for instance, Brin convinced Armstrong to establish Pozzuoli; but a few years later Armstrong decided

not to enlarge Pozzuoli's activities to include naval shipbuilding even though the Italian navy pressured them in that direction. This was because the fall in the size of the Italian naval budget had significantly reduced Italy's bargaining power vis-a-vis Elswick. Similarly, in the early 1910s Japan was able to convince Armstrong and Vickers to set up an armour making plant in the country exactly using its large naval budget as a leverage, repeating twenty-five years later the strategy Brin had used.

Even though the thesis does not address in detail the theme of the different nature of the relationships which existed between private armaments companies and financial institutions in Italy and in the United Kingdom, it is possible to advance some general remarks. The records of the British firms never point to any problem in raising resources for financing investments. Armaments firms were generally able to draw on self-financing mechanism: the sustained profitability of armaments sales generated a strong positive cash flow, to which the anticipations paid by customers should be added. Large investments, however, such as the erection of a new armour plate mill, or the enlargement of a yard, required the rapid mobilisation of very large resources, especially from the 1890s onwards. In these cases, the sophisticated British financial system easily provided firms with the required capital. The balance sheets of Vickers and Armstrong, for instance, record the issuing of debentures for millions of pounds while, at the same time, the minutes of the firms' boards hardly mention these operations. The logical conclusion is that even raising large sums does not appear to have been a problem for British armaments firms which, especially after the beginning of the German-British naval arms race, could rely on a large and growing demand for their products.

The Italian case is slightly different. Italian firms were also able to rely on self-financing which represented for many decades the major channel for raising capital. In this respect, the late 1890s were a very positive moments, thanks to the large profits generated by the sales of the *Garibaldi*. In addition to self-financing, family wealth was another important source of capital. The case of the Bombrini family is especially revealing: in the early 1880s they financed the expansion of Ansaldo using money coming from other investments accumulated by the family. Before the 20th century, Italian armaments firms were still relatively small, and their financial requirements could be met by employing these traditional channels. From 1900, however, Ansaldo's records mention various instances when the management of the firm was worried about being able to raise the capital needed for new investments. The Perrones often complained how the major Italian commercial banks offered only limited support to the company. This discrimination was motivated,

at least according to the Perrones themselves, by political reasons. On the contrary, there is no doubt that Terni's links with the Italian Commercial Bank made less difficult for this conglomerate to raise the resources it needed, even though the patchy nature of Terni's archive does not allow us to investigate this issue much further, at least from the point of view of the firm's management.[1] Again, however, it seems difficult to conclude that Ansaldo's development was significantly delayed by the supposed "antipathy" than Italian banks had toward the Perrones.

What appears to have been the most significant difference between Britain and Italy was the role of financial markets. In Great Britain, well developed financial markets made it possible for armaments firms to raise large sums by issuing debentures and other financial instruments. As stated above, by 1914 debentures and other non-banking financial instruments played a crucial role in the financing the expansion of the industry. In contrast, from the balance sheets of the Italian firms what appears evident is that Italian firms relied much less on these instruments. More research is needed, however, to understand whether this choice was the result of the less advanced nature of the Italian financial markets which deterred Italian firms from exploiting this avenue, or if this was a deliberate strategy of Italian armaments firms to avoid more scrutiny of their internal activities.

Another aspect which differentiated the British and Italian armaments industries was technological innovation. The analysis of the links between the Italian and British armaments industries allows a dynamic reassessment of the model of armaments transfer developed by Krause which has been highlighted in the Introduction. In the period from the 1850s to 1914, there is no doubt that Britain was a "first tier" country, one, that is, whose armaments industry was able to autonomously develop and produce sophisticated military technology. British firms were at the forefront of technological innovations in naval warfare: they developed and improved large artillery and quick-firing ordnance, pioneered the use of slow-burning explosives, etc.[2]

Italian companies were, by contrast, at the receiving ends of technological innovation. In the 1860s Italy was, to adopt the labels used in Krause's model, a "third tier country" because it had to import from abroad the great majority of its military hardware: for instance, in the early 1860s it purchased a large number of already fitted and armed ironclads from foreign companies because its domestic armaments industry could not manufacture them. This trend continued until the 1880s:

1 In fact, when in his multi-volumes history of the relationship between companies and banks in pre-war Italy Antonio Confalonieri deals with the Terni-Commercial Bank links he makes exclusively use of the bank's records.

2 This point has recently been restated by G. C. Peden, *Arms, Economics and British Strategy: From Dreadnoughts to Hydrogen Bombs* (Cambridge, 2007), 29-54; and D. Edgerton, *Warfare State: Britain, 1920-1970* (Cambridge, 2005), who, despite focusing on a subsequent period, highlights how the successful performance of the post-1920 British armaments industry were partially the result of its technological leadership in the pre-1914 period.

Italian armaments firms kept importing foreign technology, mainly from Britain, in the form of finished or semi-finished goods. From the 1880s, however, Italian firms steadily improved their technical capabilities to the point that, by the late 1890s, they were able to export mid-size warships to countries which, until then, had been exclusively supplied by British firms. Italy, that is, had became a "second tier country", whose military industry was capable of making more sophisticated military goods which could be sold to "third tier countries" such as Argentina. The introduction of dreadnoughts, however, reinforced British technical supremacy and damaged Italy armaments companies which had to start again the process of acquiring new crucial foreign-developed technologies. Italian firms quickly responded by importing again the required know-how although, this time, through the creation of joint-ventures and alliances with other firms rather than the purchase of finished products.

Only on the eve of the First World War, after Ansaldo and Terni completed their process of vertical integration, could Italy be defined as a "first rate country", as its success in coping with the needs of armaments production during the First World War showed. This was not a position, however, which Italy was able to maintain in the course of the following decades, as the poor performance in terms of technological evolution which characterized the Italian armaments industry in the 1930s and, especially, during the Second World War, demonstrated.[3]

In the course of the decades before the outbreak of the First World War, Italian armaments firms proved apt at replicating and adapting foreign technologies; for example, Terni was able to develop modern armour plates of a comparable quality with the ones produced abroad. Italian companies, however, did not autonomously develop any significant innovations. This limited capacity to produce technical innovation was not an exclusive feature of the armaments industry, but also characterised virtually all major Italian industrial sectors in the pre-1914 period.[4] While many reasons might have contributed to this general outcome, a few of them appear to have been especially important in the case of the armaments industry. The first one is that for many years Italian firms did not have the sheer dimension to mobilise large resources for research and development. They were simply too small to do that. Even though, for instance, trying to improve the composition of a steel plate or of a gun barrel was not necessarily very complex, the many trials needed represented an additional high cost which Ansaldo and Terni could less well withstand than the largest British (or German or French) firms.

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3 P. Ferrari, *Verso la Guerra. L'Italia nella Corsa agli Armamenti 1884-1918* (Vicenza, 2003), 235-247, offers an interesting comparison between the contrasting performance of the Italian armaments industry during the First and the Second World War.

4 This is a feature which characterised the virtually all Italian industries in the pre-1914 period, see R. Giannetti, *Tecnologia e Sviluppo Economico Italiano, 1870-1990* (Bologna, 1998).

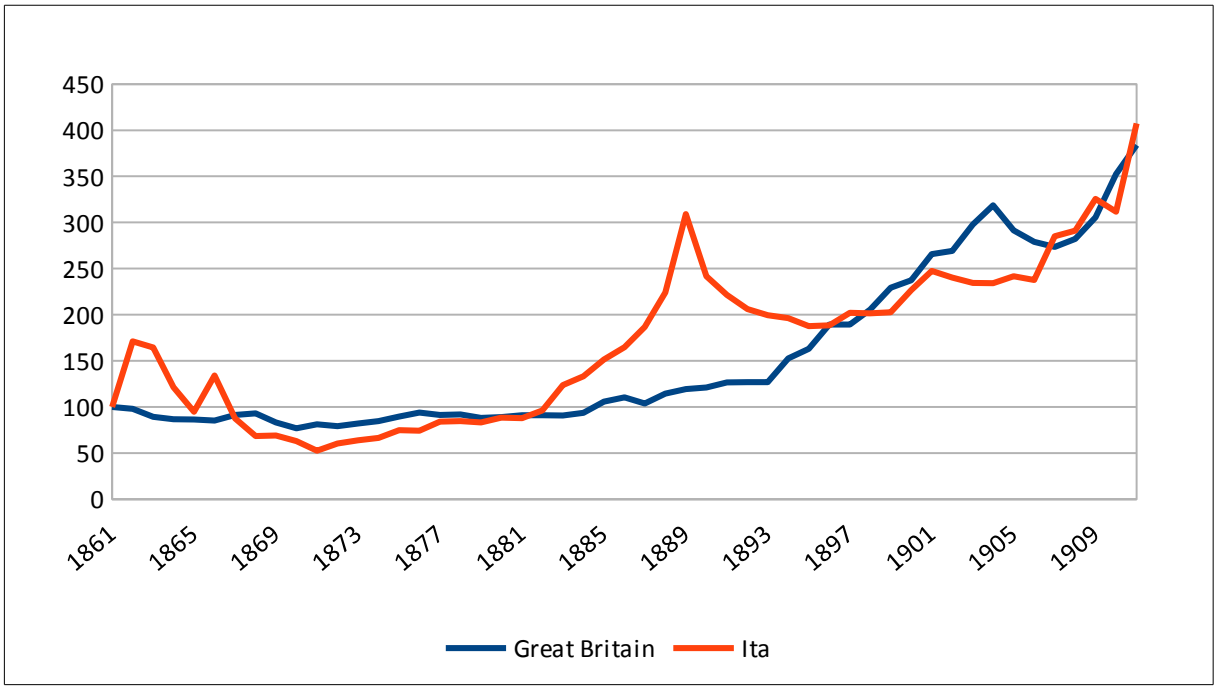
Another difference between Italian and British companies was that the latter were run for long periods by men (like Armstrong, Noble, the Vickers brothers, etc.) who were themselves very skilled engineers and innovators. In constrast, Italian firms were mainly managed by people who lacked this technical background. The Bombrini brothers, the Perrones or the Orlandos were more skilled in commercial negotiations and dealings with governments rather than in engineering matters. In addition, before 1914 the ownership of Italian armaments firms changed numerous times, something which certainly affacted the strategies and plans of firms. In addition, the ups and downs of Italian armaments spending, which had a direct impact on armaments firms' fortunes, did not favour the necessarily long-term accumulation of technical expertise. This fact explains, for instance, why even by 1914 Italian yards, despite they significantly improved their building times, were still slower than British yards. The irregular path of orders meant that firms such as Ansaldo or Orlando were not able to fully exploit the potentiality of their yards and of their workers who often found themselves unemployed for months. Not by chance, Ansaldo's yard reached the peak of its efficiency (at least in terms of construction times) when it have lined up one after the other the *Garibaldi* cruisers. The case of government yards was different: we lack systematic analyses of their activities, but it seems credible to speculate that their slow building tempo was caused by a generally poor management (they were run by naval officers, not managers), and by the fact that their workforce enjoyed a much stronger legal protection than the workers employed in the private industry (at least this is the impression conveyed by many sources published in the 1880s, and there are no indications that things changed during the following decades).

However, the single most important reason why Italian armaments firms were less prone to invest large resources in R&D activities, but relied mainly on technological transfers from abroad, was that this strategy suited best the strategic position of Italy. The Italian fleet needed to be up-to-date, but the Navy was also concerned that its warships were reliable. Thus, rather than to invest precious resources in patronising uncertain research attempts, a better strategy was that of pushing Italian firms to rapidly acquire any foreign innovation that had already proved to be successful.

Italian and British experiences diverged also in another key aspect: the degree of cooperation/competition inside the private armaments industry sector. In Britain military firms tended to collaborate among themselves. While certainly new entrants threatened established producers, but it is remarkable how British firms were able to coordinate their efforts both at home and on foreign markets (see. chapter VI) to reduce the risk of excessive competition. In comparison, the two major Italian armaments firms, Ansaldo and the Orlando-Terni-Odero group, strongly

competed against each other and showed remarkably little desire to coordinate their efforts and strategies. For example, they failed to join forces to gain a foot in foreign markets in the 1900s. The contrasting trajectories of Italian and British naval spending (rather than the absolute size of their naval budgets) in the years 1861-1911 (an interval which allows a uniform comparison) explain such difference (Figure 8.1).

Figure 8.1: British and Italian real naval expenditure, 1861-1911 (1861=100 for both countries).



Source: for Britain, figures 1.5, 3.2 and 6.1; for Italy figures 2.1, 4.1 and 7.1. British values are deflated using the website http://www.measuringworth.com/. Data on Italian spending are deflated using Istat coefficients of transformation (http://www.istat.it/it/archivio/32752).

British naval spending remained more or less constant until the mid-1880s, when it started growing, a process which was only briefly interrupted in the mid-1900s. This regular trend gave British firms an incentive to collaborate: they could predict the future level of spending with confidence, and judge their investments accordingly, enabling them to maintain constant production in their works. The collaboration extended to foreign markets where British firms were the dominant suppliers and faced competitors based in other countries. By contrast, Italian naval spending was much more irregular, peaking in the early 1860s, in the late 1880s, and in the last few years before 1914. This irregular trend meant that Italian armaments firms faced a highly unstable domestic demand, on which they relied quite exclusively. In addition, with armaments production becoming more and more capital-intensive, the firms' key preoccupation became that of keeping

their plants busy so to cover their growing fixed costs. Under these circumstances Italian firms had no incentive to collaborate; rather they tried to gain the largest share of the orders to cover themselves against the likely reduction of expenditures in the future. Once again, a careful comparison between the Italian and British cases highlights how, before 1914, to define the armaments industry in both countries as monolithic "military-industrial complexes" is misleading. By contrast, they were highly complex and nuanced sectors which rapidly evolved and adapted to changing external circumstances.

In the space of sixty years, private armaments industries moved from being none-existent to become among the largest components of the industrial sector of many economies; something which happened, for example, in both Britain and Italy. In this respect, it is interesting to notice that the great majority of firms now active in the defence industry in Europe directly descend from companies which were established in the pre-1914 period.

For the first time in centuries, non-governmental institutions started to play a determining role in military affairs. The level of autonomy and self-organisation enjoyed by private firms meant that a key function inside the sphere of military affairs – the design and production of heavy armaments – started to fall, at least partially, outside the direct control of government bureaucracies. A shift made still more significant by the fact that, because of the growing role of technology in warfare, armaments design and production became absolutely central. The private actors, who entered the armaments industry, approached it with a commercial and business-like mindset. This was, again, a radical departure from the previous centuries when armaments production had been carried on as bureaucratic tasks by government and military officials.

The decades covered by this thesis were thus the crucial moment during which the contemporary armaments procurement system, based on private firms supplying the majority of military hardware required by governments, was created. A process of commercialization and privatisation which nowadays is developing even further, with private companies playing a growing role in many other areas of military affairs.

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