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Greek Merchant Navy, Technological Change and Domestic Shipbuilding Industry from 1850 to 1914

by

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INTRODUCTION*

Greece became an independent state in 1827, after the war of liberation against the Ottoman Empire. In the nineteenth century Greece remained a less developed country. Agriculture was its main economic activity and foodstuff exports (currants, wine, tobacco and olive oil) accounted for more than 70 per cent of the annual exports between 1850 and 1914. The technology needed for processing Greek agricultural products was minimal. In the industrial sector manufacturing output was marginal and local engineering and entrepreneurial skills were scarce.

In this underdeveloped environment, the Greek mercantile marine was established as a dynamic, export-oriented sector involved in overseas trade. Its early success took advantage of the skilled labour available in traditional maritime communities in the Greek islands. After a short-lived decline during the Greek War of Independence (1821-1830), Greek seagoing tonnage emerged again as a competitive player in the world shipping market. Greek ships were largely used for conveying bulk freight from the Eastern Mediterranean and Black Sea to Western European ports.

During the second half of the nineteenth century rapid technological changes took place in the world shipping industry with steamships substituting wooden sailing ships. The long-term trend in the world shipping industry was towards specialization and increased capacity. On the supply side, technological improvements in the engineering and metallurgical sectors provided a stream of incremental innovation in the construction of iron and steel steamers.[1] The evolution of shipyards was affected strongly by the growing size and complexity of vessels which forced the transformation of shipbuilding from a handicraft activity into large scale, capital intensive firms. With the abolition of restrictions on foreign tonnage, shipbuilding increasingly became a competitive world market where shipowners had the resources and the knowledge to compare performance and prices of builders and the finished product had negligible transport costs. Of course, artificial barriers (subsidies

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* I would like to thank Professor John Armstrong for his valuable comments and suggestions.

[1]. For a review of international shipbuilding in the late nineteenth century, see S. Pollard and P.Robertson, The British Shipbuilding Industry, 1870-1914 (Cambridge,1979), pp.25-48.

and bounties) existed in late-comer industrializers in favour of domestic shipbuilding industries. But the scale of investment needed to build large and complex ships at prices that were competitive on the world market became a crucial obstacle to the gradual transformation of pre-existing links between shipowners and traditional wooden shipbuilders.

In late industrialisers the ability to develop a shipbuilding industry and to keep up with rapid technical changes in British yards was the result of the complex interaction of a number of factors. Increasing technical similarities (convergence) of metal processing strengthened the links between construction work (shipyards) and suppliers of plates, engines and components (iron and steel subcontracting firms).[1] Therefore, to be technically feasible shipbuilding plants needed external economies and linkages with local iron and steel industries. Late-comer industrial nations considered shipbuilding among their strategic priorities and therefore the development of local shipbuilding capabilities was mainly a state-driven affair.[2] In the long run, a critical advantage was a large domestic market resulting in demand continuity and allowing local builders to achieve specialization.

The state's direct role in Greece's industrialization was marginal compared to other late industrializers in Southern Europe. A number of relevant areas can be cited including the government's involvement in the creation of social overhead capital (e.g. railroads) and privileges to investors in mineral resources and light industries. Greek economic history in the nineteenth century is full of debates, government actions and decisions linked to micro interests and political bargaining. However, this mixture of government activities could hardly become a coherent "industrial policy" for the development of the local

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[1]. For the increasing importance of "convergence" in the nineteenth century in metal processing, see N. Rosenberg, "Technological change in the machine tool industry", Journal of Economic History, XXIII (1963), pp. 426-39 and for an analysis on the same lines concerning the shipbuilding industry see Pollard and Robertson, The British Shipbuilding, pp. 46-7.

[2]. On this particular issue, see Pollard and Robertson, The British Shipbuilding, p. 41; C. Trebilcock, The Industrialization of the Continental Powers, 1870-1914 (1985), pp. 343-7; A. Gomez-Mendoza, "Government and the development of modern shipbuilding in Spain, 1850-1935" The Journal of Transport History, IX (1988), pp. 27-34; S. Broadbridge, "Shipbuilding and the state in Japan since the 1850", Modern Asian Studies, II (1977), pp. 606-7. For the role of import-substitution policies, see S. Ville, "Shipping industry technologies" in D. J. Jeremy (ed), International Technology Transfer (1991), pp. 79-82.

manufacturing base.[1] The shipping sector was considered by the Greek Government an international economic activity carried out by expatriate Greeks. In other words, the fortunes of Greek shipping companies were almost exclusively determined by the fluctuation of world trade and freights. Local shipbuilding was considered an activity closely linked to shipping interests and market trends. Institutional malfunction in the implementation of "industrial policy", the adoption of free trade policies since 1836, and the abolition of protection in Greek coastal lines in 1880 could hardly conform with state support to shipping and shipbuilding.

In the Greek case, the shift of demand from sail to steam vessels interrupted, among other things, the link between the dynamic shipping sector and domestic shipbuilding. Until the early 1870s, the increasing demand for new sailing ships was easily absorbed by traditional local builders. The introduction of steam on Eastern Mediterranean routes led to the development of three major firms in the area of maintenance, overhaul and shipbuilding in Syros and Piraeus, the two principal Greek ports. These emerging shipbuilding companies developed basic metal processing infrastructure, concentrated upon the production of small wooden steam-ships and proved unable to move upwards to mechanized shipbuilding plants.

The analytical focus in this article is on the factors which undermined the development of producer-user linkages in the shipping and shipbuilding sector in Greece from 1850 to 1914, during a period of radical technical change in maritime transport and shipbuilding. The evaluation of the Greek experience is carried out on three planes: Firstly, analysis of the demand pattern, secondly, micro level analysis through the presentation of corporate performance and evolving technical capabilities and thirdly, the influence exercised by the weak domestic industrial infrastructure, state policy and the supply of skilled labour to Greek shipyards. The explanation I develop here attempts to show how technical and economic variables interacted with corporate priorities to produce the marginalisation of the Greek shipbuilding industry in the early 1910s.

The lack of reliable aggregate statistics on shipbuilding output forced me to depend heavily on data derived mainly from literary sources, Greek historical archives and the trade press.

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[1]. Ch. Agriantoni, The Early Phase of Industrialization in Greece in the 19th Century (Athens, 1986-in Greek), pp. 295-301.

THE MERCHANT NAVY

The Greek merchant navy emerged as a dynamic competitor in Mediterranean shipping in the late eighteenth century.[1] Until the 1860s Greek shipowners invested in medium-sized sailing ships with an average capacity of about 200 tons. The Greek merchant navy rapidly increased as a sailing ship fleet specializing in bulk freight such as wheat and coal from the Eastern Mediterranean, Black Sea and Danube to Western Mediterranean and British ports.[2] Sailing tonnage declined in the 1870s due to increasing difficulties in adjusting to the new terms of competition in world shipping. The steamship tonnage increased from twelve ships of 5,360 tons in 1870 to 122 ships of 115,000 tons in 1900 and soared by a factor of 4.8 to 550,000 tons in 1915. Steam tonnage outstripped sail in 1901 (163,000 tons against 148,000 tons; for the evolution of sail and steam tonnage, see Table 1). The Greek merchant navy adopted steam technology with a considerable delay following a long-standing decline of Greek sailing ships in the Mediterranean.[3] In Spain and Holland, for example, steam tonnage was 83 and 76 per cent of the total tonnage respectively in 1900 while in Greece it was 48 per cent (see Table 2).

World shipping grew in the period 1850-1880, stagnated during the 1890s and increased rapidly in the period 1900-1910. During the period 1850-1900, the Greek share

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[1]. For the historical evolution of the Greek shipping industry, see G. Leontaritis, Greek Merchant Navy,1453-1850 (Athens, 1981-in Greek) and V. Kremmidas, Greek Shipping Industry, 1776-1835 (Athens, 1985-in Greek).

[2]. Leontaritis, Greek Merchant, p. 54; Ch. Issawi, An Economic History of the Middle East and North Africa (1980), pp. 152-3. For the significant participation of Greek shipowners in the Black Sea trade to Europe, see G. Harlaftis, "The role of the Greeks in the Black Sea trade, 1830-1900", in L. R. Fischer and H. W. Nordvik (eds), Shipping and Trade, 1750-1950: Essays in International Maritime Economic History (1990), pp. 90-5 and P. L. Cottrell, "Liverpool shipowners, the Mediterranean, and the transition from sail to steam during the mid-nineteenth century", in L. R. Fischer (ed), From Wheel House to Counting House: Essays in Maritime Business History in Honour of Professor P. N. Davies (1992), pp. 155-8.

[3]. M. Panopoulou, Economic and Technical Problems in the Greek Shipbuilding Industry, 1850-1914, unpublished D. Phil. Thesis, Athens, 1991 (in Greek), pp. 133-7. Norway followed a similar pattern of delayed diffusion of steam technology in its merchant marine. In that case, however, sailing ships remained competitive and sail tonnage increased until the 1890s; see O. Gjoeberg, "The substitution of steam for sail in Norwegian ocean shipping, 1866-1914, a study in the economics of diffusion", Scandinavian Economic History Review, XXVII (1980), p. 141.

TABLE 1
Greek sailing and steamship tonnage

(Net registered tons)

	Sailing ships			Steamships		
Year	Number of ships	Total tonnage	Average tonnage	Number of ships	Total tonnage	Average tonnage
1835	3,170	82,420	26	-	-	-
1840	3,184	110,190	35	-	-	-
1845	3,584	161,103	45	-	-	-
1850	4,016	266,201	56	-	-	-
1854	4,230	250,000	59	-	-	-
1860	4,069	262,925	65	1	150	-
1865	5,743	327,000	57	1	150	-
1870	5,871	398,703	68	12	5,360	447
1875	5,410	254,000	47	27	8,241	305
1885	3,141[a]	225,000	72	72	36,000	500
1888	5,731	217,000	38	98	32,325	330
1890	5,744	227,000	39	97	44,684	461
1895	1,164[b]	251,000	216	112[b]	81,000	723
1900	927	184,000	198	122	115,000	943
1905	551	145,000	263	183	226,000	1,235
1910	804	145,000	180	298	313,000	1,050
1915	784	107,000	136	474	550,000	1,160

Notes: [a] Sailing ships larger than 60 tons.
[b] 1895-1900 ships larger than 50 tons and from 1905 ships of 60 tons or over are included.

Sources: B. Mitchell, European Historical Statistics 1750-1970 (1976), pp. 616, 621, with adjustments from data provided in the Annual Tables of Foreign Trade (Greek Ministry of Finance, Athens).

TABLE 2

Percentage shares of world tonnage and steam tonnage as percentage of total tonnage for major merchant fleets, 1850-1910

(Net registered tons)[1]

	1850		1860		1870		1880	
Nation	Share	Steam %	Share	Steam %	Share	Steam %	Share	Steam %
Great Britain	34.1	3	31.4	7	32.7	12	34.6	27
USA	13.4	2	12.9	2	7.5	7	7.6	14
Germany	5.2	1	5.4	3	5.5	5	5.9	11
Norway	3.0	0	3.6	1	5.3	1	7.5	2
Canada	4.4	2	4.5	2	5.5	3	6.6	5
France	7.0	2	6.8	6	6.0	12	4.5	20
Italy	1.8	0	1.5	2	4.9	2	4.2	5
Sweden	2.1	1	1.9	3	1.8	4	2.7	9
Spain	2.5	1	2.6	3	2.2	11	2.1	18
Russia	N.A.	-	N.A.	-	1.5	13	1.7	15
Holland	3.4	1	3.0	2	2.2	3	1.8	12
Denmark	0.9	1	1.0	2	1.0	4	1.3	14
Finland	1.0	0	1.2	1	1.4	1	1.4	3
Belgium	0.3	4	0.2	3	0.2	17	0.3	55
Greece	2.8	-	1.8	-	2.3	1	1.4	11
Estimated World Tonnage	9,374		14,864		17,803		19,843	

	1890		1900		1910	
Nation	Share	Steam %	Share	Steam %	Share	Steam %
Great Britain	34.8	63	34.5	79	32.9	91
USA	7.6	30	7.5	40	8.7	56
Germany	6.7	62	7.2	71	8.3	84
Norway	6.9	10	5.4	35	4.4	59
Canada	4.1	7	2.0	19	1.8	34
France	4.0	61	3.7	60	4.2	64
Italy	4.2	24	4.0	60	2.9	63
Sweden	2.7	26	2.1	50	1.8	76
Spain	1.9	60	2.1	83	1.5	91
Russia	1.6	26	1.2	50	1.2	76
Holland	1.5	46	1.2	76	1.4	89
Denmark	1.2	38	1.3	69	1.4	85
Finland	1.1	10	1.1	15	0.7	22
Belgium	0.2	94	0.3	97	0.4	98
Greece	1.2	16	1.1	48	1.3	69
Estimated World Tonnage	23,305		26,261		34,353	

1. All national tonnage figures have been converted to British net tons.

Source:L. Fischer and H. Nordvik, "Maritime transport and the integration of the North Atlantic economy,1850-1914", in L. Fischer, R. McInnis and J. Scheider (eds), The Emergence of a World Economy 1500-1914, Part II (Stuttgart, 1986), Tables III and IV and for the Greek tonnage and steam percentage Table 1 in this article.

of world tonnage declined from 2.8 to 1.1 per cent. The Greek merchant marine lost out during the period of increasing international demand in the 1880s whereas its position was mainly upheld during the depression in world shipping after 1891. After 1900 the Greek shipping industry was successful in adopting steam technology and recovered from a downturn of almost 30 years (see Table 2).

In the first half of the nineteenth century local shipyards building wooden sailing ships forged close links with the Greek shipping community. The larger vessels usually built were hermaphrodite brigs, barquentines and schooners; the smaller craft were generally restricted to the well-known Levantine caiques.[1] The volume of wooden shipbuilding increased considerably until the 1870s. Every year in Syros, the main Greek shipbuilding centre, about eighty sailing ships were under construction. About two thirds of these new vessels were medium-sized brigs of 150-400 tons.[2] The construction of sailing ships, however, remained a handicraft activity employing traditional shipwrights. Local yards had limited technical capabilities and their fixed capital was low. Their infrastructure was basically buildings and storage facilities.[3] The workforce received basic training in handicraft work through traditional apprenticeship.[4] Incentives to improve production techniques and technical capabilities came from shipowners and took the form of demands for increasing capacity and safety. These improvements were limited to the import of technical designs and the employment of naval architects educated in western countries. The influence on fixed capital investment and infrastructure improvements was limited.[5] Therefore, local timber yards retained their traditional character as small scale, handicraft plants closely linked to the fluctuations in sailing ship turnover.

Wooden shipbuilding faced a decline in orders for sailing ships during the period 1870-1914 as a result of the decreasing competitiveness of the Greek merchant sailing

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[1]. Accounts and Papers, 1984, LXXXVI, p. 504. A clear picture of the specialization in brigs comes from annual data from the Cyclades Historical Archives Hermoupolis, I/Shipbuilding, file 1-16.

[2]. Agriantoni, The Early Phase, p. 89-90.

[3]. V. Kardasis, Syros, the Cross-Road of Eastern Mediterranean (Athens, 1987-in Greek), p. 170.

[4]. T. Konstandinidis, Ships, Captains and Sailors, 1800-1830 (Athens, 1954-in Greek), pp. 120-2.

[5]. Ibid, pp. 115-20; Nautiki Hellas, 1 June 1971; Kardasis, Syros, the Cross-Road, pp. 171-2.

fleet. The stagnation of demand had severe effects on the local economy of Syros which was linked to shipping and shipbuilding activities (see Table 3). Only occasional attempts were made at the introduction of modern shipbuilding techniques and the construction of steamships in traditional yards. These traditional handicraft plants could hardly cope with the scale of investment and day-to-day technical requirements of iron and steel shipbuilding. They failed to diversify into the production of steamers and new firms emerged in the market for maintenance services and shipbuilding.

The Greek merchant navy was traditionally involved in foreign shipping markets. Greece was a small and industrially poor nation. Its volume of foreign trade was only a small fraction of the seagoing tonnage owned by the Greek fleet. Until the mid-nineteenth century the volume of trade from/to the Eastern Mediterranean, the abolition of protection for the British merchant navy and the development of a network of commercial and shipping agents among Greek expatriots provided Greek shipowners with rare opportunities for rapid expansion. As their first steps in the steamship market Greek shipowners acquired second-hand British ships. In the late 1880s Greek shipowners started acquiring new steamers from British shipyards. The flow of orders for new steamers took-off from 1901 to 1914 but second-hand ships remained the majority of acquisitions (see Table 4).

The expansion in international trade led to a corresponding demand for shipping. This demand gave export-oriented Greek shipowners an opportunity for growth and Greece's fleet of steamships became the tenth largest in the world. While in 1890 the Greek merchant navy had 97 steamers with an average tonnage of 460, its fleet increased to 474 ships averaging 1,160 tons in 1915 (see Table 1). In the long run, the prosperity of Greek shipowners was based on their competitiveness in the world shipping market, i.e. their ability to match emerging market opportunities with appropriate maritime technologies, cheap labour costs and trading experience.[1]

The creation of the independent Kingdom of Greece produced a wide range of domestic demand for maritime steam services extending from official mail to coastal lines and national defence. In the 1890s, an additional demand for shipping services emerged

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[1]. A. Andreadis, "La marine marchande Grecque", Journal Economistes, LXXII (1913), pp. 80-150. Recent empirical research, however, suggests that there were also periods of recession due to overcapacity and mismanagement; see Ch. Hatziiossif, "Conjunctural crisis and structural problems in the Greek merchant marine in the 19th century: reaction of the state and private interests", Journal of the Hellenic Diaspora, XII (1985), pp. 5-20.

with the considerable increase in emigration from Greece to the USA.[1] Due to the lack of protection for Greek shipping, domestic demand for shipping services was exposed to foreign competition.

The diffusion of steam in Greek shipping was linked to changes in the demand for shipping services and relative prices of freights for sail and steam. The substitution of sail by steam vessels started by coastal lines in the 1860s and from 1895 onwards became the dominant trend in bulk-carriers. From 1860 the Greek government participated, as the major shareholder, in the Hellenic Steamship company which established a network of coastal lines between small Aegian islands and Piraeus. Border tensions with Turkey forced the implementation of expensive naval procurement programmes and the introduction of steam warships in the Greek Navy.[2]

The major share of investment in steamships, however, came from export oriented Greek shipowners. They invested heavily in steamships in two stages: from 1880 to 1890; and from 1900 to 1914. During the first period they managed profitably to employ vessels that were no longer competitive in Britain because of their cheaper labour and laxer safety regulations. The acceleration of orders for newly constructed tonnage came around 1900. These were years of prosperity for Greek shipping with sharp increases in Black Sea wheat and coal freights[3] during the Russo-Turkish War, the Hispano-American War and the Boer War. Increasing returns were invested in new vessels and, moreover, Greek merchants and well-established shipping companies in European commercial centres (London, Marseilles, Amsterdam) financed purchases by smaller Greek shipowners.

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[1]. During the period 1890-1914 emigration from Greece to the USA was 260,000, or 25-30 per cent of the total male population aged between 15 and 25 years; see D. Psyhogios, "A contribution to demographic trends in the 19th century", Epitheorisi Kinonikon Erevnon, LXIII (1986-in Greek),pp. 163, 168.

[2]. A regional naval race was established between Greece and Turkey in the first two decades of the twentieth century; see J. Malakasses, The Greek Naval Building Program in 1910-1914 and the USA (Ioannina, 1978).

[3]. The general level of freight declined until the early 1890s as steam technology was introduced into the shipping industry. However until the end of the nineteenth century, for key Mediterranean and Black Sea destinations, freights increased as a result of wars and blockades on world shipping. For example coal export freights to the Mediterranean and wheat freights from the Black Sea increased from 5.7 and 9.0 shillings in 1895 to 10.8 and 10.0 in 1900 respectively. C. Harley, "Coal exports and British shipping, 1850-1913", Exploration in Economic History, XXVI (1989), App. Tab. 3 and 4, pp. 334-7.

TABLE 3

Sailing merchant tonnage built in Syros, 1856-1912

(Registered tons)

Year	Ships	Tonnage
1856	84	N. A.[a]
1858	81	N. A.[a]
1860	75	N. A.[a]
1863	91	N. A.[a]
1866	56	N. A.[a]
1871	79	11,088
1875	88	10,483
1880	70	6,168
1883	50	2,197
1886	23	1,800
1890	61	8,673
1893	41	4,289
1895	36	1,490
1900	10	N. A.[a]
1903	16	N. A.[a]
1906	13	862
1910	12	577
1912	5	248

Note: [a] Not available.

Sources: Annual reports from British Consuls, Greece, Accounts and Papers, various years and Cyclades Historical Archives, Hermoupolis, I/Shipbuilding, file 1-16.

TABLE 4

New Greek steamers, 1898-1914

{Net registered tons (NRT)}

Year	Number of steamers	NRT
1898	1	2,192
1901	4	6,812
1902	9	17,809
1903	5	10,208
1904	4	7,761
1906	4	7,702
1907	6	14,356
1908	6	13,991
1909	1	2,558
1910	1	1,822
1911	1	2,146
1912	6	15,158
1913	5	12,202
1914	8	21,097
1898-1914	61	135,814

Sources: Nautika Chronika, 15 June 1956, Lloyd's Register of British and Foreign Shipping (various years).

Following the rapid diffusion of steam in the Greek merchant navy a clear distinction became evident between large shipping companies working mainly for the international market and smaller companies involved in regional trade and coastal lines located mostly at Piraeus.[1] In 1915 the five largest Greek shipping companies were Empiricos, Valianos, Moraitis, Stathatos and Michalinos. During the period 1898-1914 these five companies purchased 2.7 per cent of the total newly built merchant tonnage for foreigners in the United Kingdom (34 ships of 79,566 tons).[2] The smaller companies served the local/regional market for shipping services. Panellinic and Pantaleon owned ten ships, MacDowall seven and Goudis four ships. Other small companies had 1-2 ships. These were small vessels, usually second-hand, and their tonnage was less than 800 tons.[3] The former group of companies was internationally oriented while the latter remained specialized in coastal and regional lines. As a response to specialization they pursued diverse demand patterns. Large firms invested in medium-sized bulk carriers (1,500-4,000 tons) and liners (3,000-7,000 tons) and the group of smaller companies acquired ships with an average tonnage of less than 800 tons. During the first quarter of the twentieth century, the fleet of large Greek steamships grew faster in comparison to small steamships.[4]

The substitution of sail by steam had little effect on the traditional specialization pattern of Greek shipping. Exports of wheat from the Black Sea, Turkey and the Danube to Italian and Western European ports remained the main activity. The largest share of Greece's merchant fleet was engaged in international rather than national trade. During the period 1873-1893 the increased domestic demand for shipping services was marginal reflecting the average annual rate of growth in Greece's foreign trade of 0.65 per cent. In the next twenty years (1893-1913), however, foreign trade increased by 2.42 per cent annually thus increasing demand for shipping services. The domestic demand for new products, for example coal and cotton from England and Scotland, considerably increased

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[1]. Most large Greek shipping companies established offices in London. See D. Dakin, The Unification of Greece (Athens, 2nd edition, 1984-in Greek), pp. 379-80; Sphera, 17 March 1911; Argo, January 1968, pp. 85-96.

[2]. Our calculations from Pollard and Robertson, The British Shipbuilding, Table B.8, pp. 250-1 and Nautika Chronika, 15 June 1956, p. 7.

[3]. M. Panopoulou, Thesis, Table 3.19, p. 369.

[4]. For these particular trends, see Sphera, 24 October 1900; 21 November 1906 and 2 February 1913.

the revenue from return trips and thus overall profits.[1] The value of the country's coal imports increased from 1872 to 1900 by a factor of 3.6, up from 2,684 million drachma to 9,686 million drachma. The expansion in other markets, for example the North-Atlantic trade, came only after the introduction of large liners and specialized bulk-carriers in the Greek fleet.[2] Generally speaking, the emphasis on the bottom-end of the shipping market was a rational choice, at the corporate level, but it increased the severity of fluctuations in annual shipping output. By the end of the nineteenth century, the Greek shipping sector was still dependent on a small number of products and freights.

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[1]. For a detailed account of profitable Greek shipping activities, see Sphera, 15 January, 16 March 1911 and 14 September 1913.

[2]. M. Panopoulou, Thesis, p. 164.

THE SHIPBUILDING SECTOR:
PRODUCT RANGE AND TECHNICAL CAPABILITIES

The development of steamship construction and maintenance capabilities took place in three newly established firms in the 1860s. The pre-existing infrastructure proved unable to keep up with evolution in the demand pattern. The first of these new yards was actually a division of the Hellenic Steam Navigation company and it was founded in 1859, in the Aegian island of Syros with generous government financial support. Two private firms followed a few years later. The Messrs Vasiliadis and John MacDowall yards were established in Piraeus in 1861 and 1873 by a Greek expatriate merchant and a Scottish engineer respectively.[1] The three main yards were established as small repair and engineering plants.[2] Throughout the period in question, their corporate strategy was to secure a constant flow of repairs and at a second stage to capture part of the local/regional market for new steam-ship construction.

Firstly, the increasing participation of steamers in Mediterranean shipping created an accelerating demand for specialized repair work in the region.[3] Repair requirements from Greek and foreign vessels produced a significant number of orders for the local yards. In fact, repair work was the only secure market in periods of stagnation. Also, the Greek navy occasionally used Vasiliadis and MacDowall for repair work. Secondly, they catered for the market for steamships. Their production range comprised mainly small wooden steamers for the Greek market and, to some extent, for customers in Turkey and Russia. Thirdly, the shortage of general purpose engineering firms in Greece provided the yards with an additional market for engineering services, simple machines and metal parts. The import

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[1]. In addition to these three principal yards there were several minor workshops involved in maintenance work.

[2]. In the days of wooden ships, repairs were largely a matter of recaulking the hull and daily routine overhaul. However, an iron or steel vessel was periodically dry-docked for the purpose of scraping, cleaning and repainting the underwater surface of the hull, quite apart from any docking due to damage. The technical requirements for repair work on steamships included specialized skilled labour, always at high pressure against time. J. Mitchell, Shipbuilding and the Shipbuilding Industry (1923), pp. 82-8.

[3]. The Hellenic Steamyard was the first maintenance centre for steamers in the Eastern Mediterranean.

of agricultural machinery and the construction of industrial plants created this new area of demand.[1]

The production of many different products became feasible because of the technical similarities in shipbuilding, shiprepairing and metal processing.[2] The basic operations in nineteenth century steam shipbuilding were punching and drilling holes, cutting and shaping the components and riveting the pieces at the berth. Similar handicraft skills were important in shiprepair work and in the production of metal parts and simple machines. Therefore, yards with basic engineering infrastructure could easily diversify into different markets in the broad area of engineering products and services when the scale of these projects required limited fixed capital infrastructure.

The accumulation of technical capabilities in Greek yards had a "learning by doing" character. During their infant stage, general repairs, stationary steam engines, marine boilers, and steamship repair were the main production activities. Eventually, through the accumulation of technical experience and investment in machine tools it became possible to move upwards to construction work. The most significant technological achievement in the Greek yards took place in 1892 with the construction of an iron steam-ship of 172 tons and a triple expansion engine of 600 HP.[3] Both of them were built by MacDowall. Engineering work was conducted in his facilities in Piraeus and final assembly in his yard in Syros. The same company developed a marine engine of 1,000 HP in 1899.[4]

From the 1880s to the end of the nineteenth century, domestic firms concentrated their efforts on wooden steam-ship construction.[5] Wood from neighbouring forests continued to be much cheaper than metals and the production of wooden steamers required limited in-house technical capabilities. By 1903, approximately fifty wooden steamships had been built in Greek yards for local small shipping lines, with an average

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1. Sphera, 12 January 1896; S. Grigoriadis, Economic History of Modern Greece (Athens, 1975-in Greek), p. 25; Acropolis, 20 October 1887.

2. For the benefits (spillovers) from core metal processing activities to the broader industrial system, see Rosenberg, "Technological change", pp. 422-4; M. Fransman, Machinery in Economy Development (1986), pp. 21-2.

3. Sphera, 2, 9 January 1898, 25 February 1898; Argo, July 1975, p. 90.

4. Sphera, 23 March 1898 and 16 August 1899.

5. Unfortunately, due to the lack of reliable annual data on domestically built tonnage, we can provide only rough estimates of shipbuilding output.

capacity of 100-200 tons.[1] After 1905 the three yards failed to make a transfer into steel steamship construction, demand for wooden steamships declined, and by the end of the period they became almost exclusively dependent on repair and maintenance work.

Compared to the large increase in steamship purchases by Greek shipowners, the total output of the Greek shipyards remained marginal. In 1885 the Greek shipping industry had seventy two steamships of 36,000 tons and by 1915 it had 474 ships of 550,000 tons an increase of 402 ships and 514,000 tons (see Table 1). The domestic shipbuilding industry supplied fifty ships of, approximately, 10,000 tons, or 2 per cent of the total new tonnage.

In the nineteenth century the evolution of shipyards was affected most strongly by the growing size and complexity of vessels and the resulting increased differentiation in the building of ships. The shipbuilding industry itself was subject to constant change and adaptation. Greek shipyards emerged in an underdeveloped industrial environment without a sufficient pool of skilled labour. The absence of bounties and subsidies exposed domestic demand to foreign competition.[2] Therefore, the link between demand and local builders was weak in a highly cyclical industry. Their investment priorities were driven by a fraction of the shipping market (repair work) and they concentrated on the import of relatively stable technologies used in maintenance work. The machines used in repair work were standard cutting and drilling equipment, a highly diffused technology in the late nineteenth century.[3]

The three Greek yards imported machinery dedicated to simple metal processing and auxiliary equipment for vessel maintenance such as cleaning and painting. They were equipped with simple lathes, planes, hammers, saw-mills, drills and small cranes of 10-15 tons.[4] Central steam engines powered their machinery. Until the early 1890s shipyards

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[1]. Acropolis, 23 November 1903.

[2]. Accounts and Papers, 1898, XCII, p. 103.

[3]. A. Milward and S. Saul, Economic Development of Continental Europe, 1780-1870 (1973), pp. 211-13.

[4]. National Bank of Greece Historical Archives, XXV Projects, A Shipping, file 32 (4) and XID John MacDowall, file 92.

operated with this primitive infrastructure.[1] Their most significant investment was the installation of furnaces for iron casting.

From the 1890s increasing investment took place in Greek shipyards, including new plant and machinery. Attempts at increasing construction work were short-lived and dependence on the repair market became even stronger. The size of the plants increased considerably in the case of Vasiliadis and Hellenic Steam.[2] The increasing power of central steam engines is a clear indication of that mechanization process. In the 1880s MacDowall was working with a central power of 80 HP and in 1903 the same yard had an installed capacity of 400 HP.[3] Systems of hydraulic power were introduced in Greek yards between 1900 and 1910. The workshops were fitted with the latest pneumatic and electric machinery. Also, significant upgrading of maintenance capabilities took place with the construction by the Vasiliadis yard of a crane on a railway situated at the entrance of Piraeus harbour capable of lifting 3,000 tons.[4] Indeed, the focus of fixed capital investment was on facilities and equipment linked to maintenance and overhaul (for Vasiliadis investment strategy as taken from the company's annual reports, see Table 5).

Shipbuilding is a final assembly activity which depends on a large number of intermediate inputs from metal processing industries. In the Greek case, the development of a domestic iron and steel industry in the late nineteenth century was marginal.Therefore most of the intermediate inputs were imported. In-house capacity was utilized only in the case of defective parts and plates in repair work in order to meet specific requirements. Overall, the bulk of metal parts and auxiliary equipment was imported.[5]

The lack of an iron and steel industry became an obstacle to the development of Greek shipyards. Production costs were higher than those of foreign competitors as a result of additional transport charges and production was carried out with a great degree of uncertainty because delivery times and technical specifications of intermediate inputs were

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[1]. Accounts and Papers 1873, 1874, LXIV, pp. 308-12 and LXVII, pp. 134-5; Poseidon, 17 June 1872 and Sphera, 19 November 1888.

[2]. For Vasiliadis and MacDowall see Sphera, 9 January 1898 and for Hellenic Steam see National Bank of Greece Historical Archives, XID Loans, file 45.

[3]. Sphera, 6 and 19 November 1888.

[4]. Accounts and Papers 1909, XCV, p. 679 and Sphera, 15 December 1896 and 9 May 1903.

[5]. Panopoulou, Thesis, pp. 226-41.

TABLE 5

Vasiliadis fixed capital investments, 1896-1912

(Thousand Greek drachma, current prices)

Categories of investment	1896	1898	1900	1902	1904	1906	1911	1912
Hand tools and auxiliary equipment			150	390	260	350		250
Workshop machinery	740	390	110	260	750	17	210	100
Land	720							
Engineering design				1,540				
Floating dock					13,500	10,750	450	1,000
Total	1,460	390	260	2,190	14,510	11,117	660	1,350

Source: Panopoulou, Thesis, Table 5.1, p. 372.

defined by foreign suppliers. An additional problem was the general weakness of local industries in metal processing and construction work. International experience shows that technical improvements in the design and construction of haulage and marine engines were introduced successfully in shipyards only when the general technological level of the engineering industries was able to provide knowledge, machinery and intermediate inputs.[1] In the Greek case, the lack of this infrastructure undermined the development of local technical capabilities in advanced shipbuilding work.

In the construction of wooden sailing ships, almost all the men engaged were either shipwrights or labourers. Steamship building remained primarily a field in which handicraft skills were still important. As the steamship became more complicated and more machines were introduced into the yards the spectrum of required skills broadened considerably.[2] Machine tools in shipyards were specific to shipbuilding, they were by no means tools designed for standard mass production. Most machine tools (designed in England, a country with a highly skilled labour force) were not necessarily introduced with the intention of eliminating skilled workers but often with the intention of enhancing their productivity.[3] Craftsmen and other skilled machine workers were equipped with technical education and on-the-job training.[4]

In the Greek yards the available workforce had limited access to technical education and on-the-job training. From the very beginning the employment policy of local yards was to enrol boys. Technical experience accumulated through apprenticeship and young employees became familiar with the requirements of shipbuilding.[5] But workers facing the increasing variety of skills required in the construction of ships needed a mix of on-the-job training and formal technical education. In-house technical education was formally

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[1]. Pollard and Robertson, The British Shipbuilding, pp. 136-7.

[2]. Ville, "Shipping industry", p. 80.

[3]. Pollard and Robertson, The British Shipbuilding, pp. 116-17.

[4]. According to Y. Fukasaku (Technology Imports and the Development of Technological Capability in the Industrialization of Japan: Training and Research at Mitsubishi-Nagasaki Shipyards, 1884-1934, unpublished D. Phil. Thesis, Sussex, 1988, pp. 143-50) Japanese builders introduced in-house programmes for technical education and training at an early stage in their development of advanced shipbuilding. She argues that these initiatives provided the yards with a skilled and experienced workforce.

[5]. Panopi, 18 and 25 November 1871 and Ethnikon Mellon, 24 July 1871.

organized only in the case of Hellenic Steamship but Greek sources have raised doubts about the efficiency of these training courses.[1]

At the national level, a small number of technical schools was founded. Until the 1870s most of them were charities for orphans which, among other things, provided basic elements of technical education.[2] Since then, more specialized technical schools were established in Piraeus, the main industrial and shipbuilding centre.[3] These schools were not relevant to the increasing sophistication of the shipbuilding trades. The lack of technical education created shortages of skilled workers and capable technicians.

Similar problems emerged in the case of naval architects and engineers. They needed an increasing level of technical sophistication in order to take advantage of new scientific knowledge applicable to shipbuilding. Although in Greece engineering was introduced at the university level in 1837, the engineering curriculum remained rather theoretical, without much emphasis on technical training and industrial applications.[4] Only a limited number of capable Greek engineers was available in the local market. The Greek yards hired foreign engineers (mainly British) for production management and inspection work. In the Hellenic Steamyard British engineers were in charge of its main divisions working under the overall coordination of D. Smith. The MacDowall yard was established by the Scottish engineer, MacDowall, who invited British technicians to work for his company. The Vasiliadis yard employed Greek technicians at an early stage but its involvement in more complex engineering and shipbuilding work forced the management to hire British engineers.[5] In all three of them, the substitution of foreign with Greek naval architects and engineers was occasional without a coherent and well organized policy for the development of engineering skills among Greek inhabitants.

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[1]. Panopi, 18 November 1871.

[2]. A. Mansolas, Official Statistics about Greece (Athens, 1867-in Greek), pp. 56-62.

[3]. G. Charitakis, The Greek Industry (Athens, 1927-in Greek), pp. 101-2; Sphera, 14, 29 November 1901 and 22 November 1906.

[4]. Charitakis, The Greek Industry, pp. 85, 162; J. Lampe, "Varieties of unsuccessful industrialization: The Balkan States before 1914", The Journal of Economic History, XXXV (1975), p. 70.

[5]. D. Krinos, "Nineteenth century yards and ironworks in Syros", Nautiki Hellas, CCLII (1954-in Greek), p. 12; Agriantoni, The Early Phase, p. 198; Piraeus Historical Archives, 1875, file B.

Private firms and the Naval Shipyard were the two importers of maritime technology in Greece. At an early stage, the transfer of technology took place through machinery purchases for newly established yards. Later on, the expansion of production capacity and specialization in repair work was followed by additional investment in floating docks and specialized machinery. Provided that financial resources were available, the import of shipbuilding machinery was a normal commercial transaction. The transfer of engineering skills, however, was a more complicated affair. The basic flow of technical experience came through foreign engineers. A small fraction of Greek naval architects and engineers acquired technical knowledge in foreign technical schools, worked as employees in foreign yards and gained access to maritime technology during visits to commercial fairs. Naval officers were introduced to shipbuilding design during their education at foreign naval schools.[1]

Besides the diversity of forms of technology transfer the actual scale of technological transactions with foreign partners was marginal. Maritime technology applications were restricted to the construction of simple vessels and maintenance. Moreover, technology transfer was under the control of different domestic actors. Each of them pursued his own priorities. Initiatives from the Navy and the government came as a response to naval procurement requirements without much consultation with the local shipbuilding sector. Private builders, for their part, imported production technology and hired foreign engineers following short term market trends.[2] The few occasional attempts towards more advanced shipbuilding projects required project-specific technical knowledge and dedicated equipment. The absence of satellite firms forced the yards to develop vertically integrated capabilities in every area of their production activities. The basic decision was to produce or import without much horizontal integration being made between local firms. This investment pattern created a heavy burden of additional costs in every project. The lack of local technical capabilities also created serious problems in the adaptation of foreign technology to domestic conditions. In summary, the lack of coordination among domestic actors and the weak industrial infrastructure framed the low degree of technological assimilation in the Greek shipbuilding sector.

A brief comparison of the domestic shipbuilding infrastructure with the evolution of the shipbuilding industry in industrialised countries indicates the lateness of the Greek

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[1]. Greek engineers were usually trained at the Austrian Lloyds' shipyard in Trieste and in engineering firms in Karlsruhe. Poseidon, 8 May 1878 and Sphera, 31 July 1912.

[2]. Panopoulou, Thesis, p. 266.

firms. In world shipbuilding, iron substituted wood as the basic material in hull construction in the 1860s while in Greece most of the locally built vessels were wooden. The same trend was evident in the production of simple marine engines based on copied, thirdy-year old designs. In the international shipbuilding sector technical change was part of a more general trend towards specialised and large scale yards. In the Greek case, the size of shipbuilding firms remained small and the level of specialization was low by international standards. During the first years in operation aggregate employment in all three yards was 200 employees and in the early 1900s their total workforce was 700-800 employees.[1] According to a private report in 1913, the total estimated value of all shipbuilding establishments in Piraeus was £450,000.[2] By comparison the capital necessary for a fair-sized yard in England in the same period was between £300,000 and £1 million.[3] Obviously the Greek yards were facing a significant competitive disadvantage in terms of scale and technical capabilities in comparison to foreign competitors. When it became clear that the Greek shipping industry prefered large sophisticated vessels, local yards were unable to survive as steamship builders and their dependence on repair work re-emerged as a viable solution.

The Greek shipbuilding infrastructure eventually became a major maintenance centre in the Eastern Mediterranean. The privileged geographical position of Piraeus and Syros on Mediterranean routes and the close links between maintenance firms and Greek shipowners were the main comparative advantages of these yards.

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[1]. Piraeus Historical Archives, 1863, file A; The Syros Shipping Conference (1.9.1902), Merchant Shipping, papers and proceedings (Athens, 2nd edition, 1973-in Greek), pp. 261-4; Sphera, 19 November 1888; P. Kabouroglou, History of Piraeus (Athens,1883-in Greek), p. 87.

[2]. Accounts and Papers 1912-13, XCVII, p.10.

[3]. Pollard and Robertson, The British Shipbuilding, p. 82.

THE NAVAL SHIPYARD

The naval procurement market was linked to the modernization of domestic shipbuilding and foreign technology transfer. When Greece became an independent state the development of capable naval forces was among the first priorities of the newly established authorities. The Ministry of Naval Affairs financed a construction programme for sailing warships and in 1827 the first Naval Shipyard started operating in Poros, a small island south of Athens.

The Naval Shipyard absorbed significant investment funds from the defence budget but raised serious doubts as to its effectiveness. When it was based in Poros, strong criticism was raised about management practices which favoured investment in buildings and auxiliary facilities at the expense of workshops and machinery. By harbouring the fleet in a port thirty five nautical miles from Athens, naval forces could hardly provide protection to the Greek capital and its port from potential aggressors. After many discussions concerning the selection of the best location for the permanent construction of the Naval Shipyard, it was decided in 1881 to transfer it closer to Athens-to the island of Salamina.[1] In Salamina the selection of investment priorities was more rational. First of all, a floating-dock was imported from France with a total capacity of 3,000 tons and a floating crane was installed with a lifting capacity of 50 tons. At the same time, modern metal processing machinery was imported.[2]

The evolution of the Naval Shipyard was determined by the Ministry of Naval Affairs. An ambitious programme, including the construction of wooden steamers in the late 1830s, proclaimed the production of large timber hulls (180 to 430 tons) and the installation of imported steam engines of British origin.[3] These projects were carried out successfully with the technical assistance and direct participation of thirty Bavarian technicians.[4] For the three subsequent decades the Naval Shipyard went through a steep recession and its activities were cut down drastically. The sharp decline of naval

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[1]. J. Rouskos, "Poros Navy Yard", Nautiki Epitheorisi, 375 (1975-in Greek), pp. 119-20; V. Kapsabelis, A Marine Manual of 1897 (Athens, 1897-in Greek), p. 36.

[2]. Kapsabelis, A Maritime Manual, pp. 37-46; idem, Maritime Manual (Athens, 1907-in Greek), p. 216.

[3]. Great Greek Encyclopedia, XII, p. 718; D. Fokas, Chronicles of the Greek Royal Navy, 1833-1873 (Athens, 1923-in Greek), pp. 32-7.

[4]. Government Gazette, 1 September 1836.

shipbuilding output was the outcome of budget cuts and the re-allocation of resources in favour of the Army.[1]

In the 1860s the introduction of iron steamers in the Greek Navy was followed by renewed interest in the Naval Shipyard. From the late 1870s to 1914 it expanded in terms of fixed capital and workforce and became the main maintenance centre for Greek warships. However, its actual shipbuilding programme received less attention and was limited to the construction of two small wooden steamships.[2]

In the early 1900s almost all the major European shipyards tried to gain access to the Greek programme for the modernization of the Navy with parallel proposals for the supply of maritime technology. Among the main competitors were the British firms Armstrong, Yarrow and Beardmore and the German firm Vulkan.[3] In 1912, after a long bargaining process, the contract went to the German firm Vulkan.[4] One part of the contract, with particular interest for the Greek side, was the local construction of two torpedo boats in Greek yards with German technical assistance and practical training of Greek technicians in modern construction techniques.[5] The involvement of Greek shipyards in steamship construction, in close cooperation with an advanced foreign shipyard, could have broader benefits for the domestic shipbuilding sector.[6] According to optimistic views among Greek industrialists and government officials it could stimulate its specialization in the production of small and medium-sized steamships for the regional East Mediterranean market. Unfortunately, Greek involvement in the Balkan Wars (1912) and soon afterwards in the First World War (1914-1918) brought the cancellation of this project and local firms were deprived of potential benefits.

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[1]. Great Hellenic Encyclopedia, p. 719.

[2]. Kapsabelis, Maritime.

[3]. P. Martin, Greece of the Twentieth Century (1913), p. 107.

[4]. Sphera, 27 February 1912, 13 and 28 July 1912.

[5]. Sphera, 16 June 1912.

[6]. Panopoulou, Thesis, pp. 291-2.

GOVERNMENT POLICIES

So far we have analyzed the problems facing local producers during the transition from sailing vessels to steamers. In order to compete with increasing production and process technical requirements domestic shipyards needed: a sufficient level of industrial development, a skilled workforce and local technical capabilities and, closer producer-user links with the shipping industry.

The experience of late-nineteenth century industrializers suggested that the best strategy to catch up with advanced shipbuilders was to speed up investment in mechanization and plant infrastructure. Several authors working on the shipbuilding industry have observed that state intervention was successful when a clearly defined investment strategy established manufacturing infrastructure and created a robust pool of domestic technical capabilities. In the most successful examples of advanced shipbuilding in latecomers, Germany and Japan achieved their targets with the development of a vertically integrated shipbuilding industry. This process was stimulated with selective financial incentives to shipping companies, and bounties for purchases from domestic yards and naval procurement. In Spain government policy favouring import-substitution of naval procurement had some partial success with the development of modern shipbuilding in a rather unfavorable industrial and institutional environment.[1]

Greek shipyards faced serious financial problems during the first years in operation and later, when they invested in modern machinery and fixed capital. State financial support was marginal. Moreover, its involvement meant bureaucratic procedures and delays.[2] Only in the case of Hellenic Steam did the government provide constant financial support. The state-owned National Bank of Greece was the main shareholder of Hellenic Steam and a large number of subsidies and loans were transferred directly to Hellenic

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[1]. For a detailed account of state support to emerging builders in Germany and Japan, see R. Haack, "The development of German shipbuilding", The Engineering Magazine, XVII (1899), pp. 729-42; S. Terano and M. Yukawa, "The development of merchant shipbuilding in Japan", Transaction of the Institution of Naval Architects, LIII (1911), respectively. For the Spanish naval shipbuilding programme, see Gomez-Mendoza, "Government and the development", pp. 27-34.

[2]. Patris, 13 July 1873 and National Bank of Greece Historical Archives, XID Loans, file 45.

Steam. Of the other two shipyards, only Vasiliadis received state guarantees for loans needed to rebuild its plant after it was accidentally destroyed by fire.[1]

Naval procurement from domestic private industries was a significant share of the shipbuilding output in western countries. In the Greek case only minor maintenance and overhaul naval projects were carried out by the three major yards. The two most significant contracts went to Vasiliadis and MacDowall from 1896 to 1898. It was part of a modernization programme of the ageing Greek fleet. Large scale maintenance, overhaul and upgrading work was carried out on three destroyers and two ironclad steamers.[2] In the meantime, the modernization of the Naval Shipyard established an alternative source for simple maintenance services to the Greek fleet. Maintenance work for the Navy became an area of competition between the three private yards and the Naval Shipyard. As far as efficiency is concerned, they were involved in the same kind of activities and therefore specialization benefits were marginal.

The poor infrastructure of the port at Piraeus discouraged many potential customers for repair services. Until the early twentieth century the main floating dock in Piraeus had a total capacity of 3,000 tons. The government announced its plan for the construction of two new large docks in 1891. The project experienced many delays. Finally, in March 1913 two new floating docks, one of 18,000 tons and the other of 2,500 tons, started operating. It was the first major infrastructure programme in the shipyards which was carried out exclusively with government money.[3] But it came at the end of the period under consideration and for many years, the private yards were losing a significant share of the repair market, i.e. ships larger than 3,000 tons.

Tariff protection of infant shipbuilders from foreign competitors, in terms of cheap intermediate inputs and quotas on imported vessels was a neglected area for the Greek government.[4] Generally , its policy was based on a liberal foreign trade doctrine and only well organized social groups managed to achieve favourable customs regimes. Private shipyards could exercise limited political pressure on the Greek government and therefore

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[1]. Phoni tou Piraeus, 18 October 1868.

[2]. Sphera, 6, 11, 21 February and 7 December 1898.

[3]. Piraeus Historical Archives, 1898, file C; A. Ginis, Piraeus Port (Athens, 1907-in Greek), pp. 11-14; C. Th. Zouboulidis, History and Evolution of the Port of Piraeus (Piraeus, 1932-in Greek), p. 37.

[4]. A. N. Vernardakis, On Greek Commerce (Athens, 1885-in Greek), p. 79; National Bank of Greece Historical Archives, XID Hellenic Steamship, file 44.

their demands for protection and import-substitution of metal products and steamers received less attention. On the contrary, import penetration became even easier when the government introduced tariffs on raw materials and abolished tariff protection of engineering and shipbuilding products.

CONCLUSIONS

The Greek shipbuilding tradition was interrupted in the late nineteenth century when the shift from sail to steam prevailed. Before the first world war modern shipbuilding in steel steam-ships was not successfully introduced and only ship repair was effectively established to service the growing Greek merchant marine and, to a lesser extent, the navy which depended on buying foreign tonnage.

The old yards had been successful in traditional wood and sail construction for the domestic shipping industry. These traditional yards tried to keep pace with rapid technical change in the shipbuilding sector but they largely failed to make a transfer to steamboat building.

The three new yards succeeded mainly as general engineering and ship repair establishments. In the area of construction work they concentrated on simple wooden steamers for the local market. When the demand of the Greek shipping community moved to larger and more specialised vessels the domestic shipbuilding industry failed to make the transition to large scale iron/steel construction, shipbuilding output declined and repair work became the main activity of the Greek yards.

The analysis has examined the failure of the Greek shipyards to adjust in conditions of rapid technical change and increasing demand for sophisticated final products. Local shipyards were established in a weak industrial infrastructure and their linkages with domestic subcontractors were limited. Also the accumulation of technical capabilities was undermined by the lack of basic knowledge and engineering skills in metal processing and capital goods production. Technical problems during the expansion into new areas of production forced investment in additional in-house capacity. With limited financial resources at the disposal of private firms, this expansion programme was interrupted and shipyards turned to a defensive strategy of specializing in repair. What was needed for the development of an advanced, vertically integrated shipbuilding sector was a favourable environment in terms of financial support, customs policy, skilled labour and naval procurement. In the Greek case, attempts to forge a coherent strategy among state agencies, shipping interests and local shipyards failed. Finally the prosperous Greek shipping industry purchased mainly British vessels while the local shipyards formed a regional maintenance centre with limited technical capabilities.

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