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ABSTRACT

Migration to Australia, the Transition from Sail to Steam, and the SS Great Britain*

The transition from sail to steam for emigrant ships on the route to Australia took place in the early 1880s, nearly two decades later than on the route across the Atlantic. The lag can be accounted for by the incremental improvement in steam technology and by aspects of economic and business organisation. Most of the steamship ventures that were initiated failed, but with one important exception. Brunel's pioneering steamship the SS Great Britain made 32 voyages to Australia from 1852 to 1875 with a total of nearly 16,000 passengers. The Great Britain's success provides a unique perspective on why steam failed to rule the emigrant trade until the 1880s. Among the key features are the characteristics of the ship and the way it was adapted for the long voyage to the antipodes. Also important was the shrewd management of its owners, and an element of luck.

JEL Classification: F22, N77, O33
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Introduction

The barrier of distance between Europe and Australia is a recurring theme in Australian history, best exemplified by Geoffrey Blainey's book *The Tyranny of Distance* (1966). But as he wrote, from the middle of the nineteenth century, '[t]he long era in which distance was a tyrant seemed to be fading away" (Blainey, 1966, p. 173). This was the result of the communication revolution brought about by the electric telegraph and the transport revolution created by the transition from sailing ships to steamships. Much has been written about the latter, especially on the way in which changes in the technology and organisation of shipping shaped trade and migration to and from Australia. With regard to migration, the transition from sail to steam in bulk passenger shipping took place in the early 1880s—almost two decades after it had transformed the emigrant route across the Atlantic from Europe to North America. Between 1853-7 and 1909-13 the travel time from the UK to Australia fell by 59 days and two-thirds of this is accounted for by the transition from sail to steam a (Hatton 2025).

In the first part of this paper I review the literature on the lag in the switch from sail to steam for transporting emigrants to Australia as compared with the route to North America. The most obvious factor is the incremental nature of improvements in the efficiency of steam technology. The reach of steam gradually extended to longer voyages as low pressure steam engines and paddle propulsion were improved and eventually replaced by high pressure, triple expansion engines and screw propellers. Some authors have also stressed the business and organisational aspects of the transition. These include the challenge of finding return cargoes in order to reduce waiting times and to make the round trip to and from Australia worthwhile. They also include the economic reasons that much passenger shipping still came around the Cape of Good Hope even after the opening of the Suez Canal, which until the 1880s, was used only by ships carrying mail, high-value low-bulk goods and cabin passengers. Additional light is shed on the obstacles that faced the use of steam to convey steerage passengers to Australia in the early years by looking at new steamship ventures, which from 1852 to 1876, attempted to sustain regular services to Australia but, in short order, ended in failure.

However, there is one outstanding exception, which defied the challenges that defeated others. From 1852 to 1875 the *SS Great Britain* made 32 voyages to Australia carrying a total of nearly 16,000 passengers. This iconic ship was the brainchild of pioneering engineer Isambard Kingdom Brunel. It was the first iron-hulled, screw-driven ocean-going steamer; it incorporated a range of technical innovations, and was by far the largest ship of its day. As shipping historian Frank Broeze wrote, "[o]nly the exceptional *Great Britain* could establish itself, and for over twenty years was to maintain a solitary track around the world along the routes of the sailing ships, carrying both freight and passengers. All others found that the trade involved distances as yet too long and with too little remunerative freight" (Broeze 1989, p. 6).

In the second part of the paper I examine the history of this remarkable ship. I ask the question: if the *Great Britain* was so successful, why didn't others follow for another quarter of a century? I explore how the unique characteristics of the *Great Britain* contributed to its success and longevity. A number of features stand out. One is the way in which, step by step, through a number of refits, the ship was transformed from a sail-assisted steamship to a steam-assisted sailing ship adapted to bulk transport, despite being remembered mainly as the former.[1] As such it was able to out-perform the clippers in terms of speed and reliability. But as a revolutionary ship it was very costly to construct and after running aground it bankrupted its builders. It was bought for a fraction of its original cost by Gibbs, Bright and Co. who recognised its potential for the Australian route. Its ultimate success owed much to the way that it was refitted for the Australian run, the astute management by the company, and also to an element of good luck.

The transition from sail to steam

The transition from sail to steam was a revolution in ocean transport. For merchant shipping it dramatically reduced voyage times and their variability, and this was reflected in a dramatic fall in freight rates. It has been estimated that the transition to steam could account for as much as half of the increase in commodity trade during the second half of the nineteenth century (Pascali 2017). For passengers, the transition was also profound even though fares did not fall as did freight rates. From 1850 steam gradually displaced sail, initially for transporting mail, high value-to-volume goods and cabin passengers, and eventually shifted down the value chain into shipping bulk goods and steerage passengers. But the improvements in the efficiency of steam relative to sail took time and on the longer routes from Europe to the American west coast, the Far East, and Australia sail held its own until the 1880s, and in some trades even later (Graham 1856; Harley 1971, 1988, 1989; Jackson 1980; Broeze 1989; Jacks et al. 2024; Hatton 2024b).

Steamships first crossed the Atlantic from east to west in 1838 and, for the following two decades, steamers carried mainly mail, high value goods and cabin passengers. Steam gradually displaced the sailing packets but it was not until the 1860s that it overtook sail for the transportation of emigrants from Europe to North America. Only one percent of passenger arrivals at New York came by steam in 1852 but this increased to 45 percent by 1864 and 97 percent by 1873 (Cohn 2005). The background was the improvement in the efficiency of steam, with higher pressure compound engines and the replacement of paddle wheels by screw propellers. As Cohn notes, it took some time for the shipping capacity that embodied the new technology to expand into the carriage of bulk passengers. The result was a decline in the average duration of westward voyages from Liverpool to New York from 38

[1] One reason is that the ship that is now on display at Bristol has been restored to resemble its original specification when first launched in 1843 and not the extensively modified version that later plied the route to Australia.

days in 1953-7 to just 8 days in 1909-13, 79 percent of which is accounted for by the decade-long transition from sail to steam (Hatton 2025).

For emigrant voyages to Australia the story was rather different. Up to 1880 the voyages of emigrants travelling steerage were almost exclusively by sail around the Cape of Good Hope, and more than half of them were assisted emigrants travelling on subsidised passages (Hatton 2024a). By the late 1880s emigrants journeyed mainly by steam, either via the Cape or through the Suez Canal which opened in 1869. Among passengers to Queensland, just 0.4% came by steamship 1871-80, but this increased to 75.2% in 1881-90 (Woolcock 1986, p. 349). Voyage times from the UK to New South Wales fell from an average of 124 days in 1837-41 to 86 days in 1879-83, and 46 days in 1909-13. The substitution of steam for sail in the early 1880s accounts for two thirds of the decline in voyage times from 1853-7 to 1909-1913 and for half of the decline from 1837-41 to 1909-1913 (Hatton, 2025).

Why did the transition from sail to steam on emigrant voyages to Australia (and New Zealand) lag by two decades? The existing literature provides a well-rehearsed range of factors that contributed to the timing of the transition on the route to Australia (and New Zealand). The reasons for the lag can be divided into technical reasons and commercial or economic reasons, although it should be recognised that these are interrelated.

Technical obstacles in the transition from sail to steam

The earliest steamships had low pressure boilers that consumed large amounts of coal to deliver modest amounts of power. From the 1840s to the 1860s the efficiency of steam gradually improved, first with increases in boiler pressures followed by the introduction of compound engines and later, in the early 1880s, the introduction of triple expansion engines.[2] Another factor was the introduction of screw propellers that superseded paddle wheels and provided more efficient transmission of power. Because of the low efficiency of their engines the early steamers needed to carry large amounts of coal, which used up space for passengers or cargo. And because of the need to refuel, the total voyage length was limited by the chain of coaling stations. On the route to Australia via the Cape of Good Hope there were coaling stations in the eastern Atlantic but not for the 6000 miles beyond the Cape.[3] Before the 1890s ocean-going steamers were fully rigged with sails and, when the winds were favourable, they could stop the engines and proceed under sail, or use both. Although these auxiliary steamers generally performed less well when under sail alone than the pure sailing ships, they were less at the mercy of the winds when choosing a track to follow and could make progress where sailing ships would be becalmed. While auxiliaries could economise on coal, the engines and the coal nevertheless occupied significant space. In addition to the cost of coal, they also

[2] The process of overcoming the technical and economic obstacles in the development of steamships for oceanic routes up to 1870 is described in detail by Smith (2013).

[3] Major coaling stations were Madiera, Las Palmas, St. Vincent and Cape Town, which were stocked mainly with Welsh coal (local coal at Durban became increasingly important) (Kirkaldy, 1914 Part III Ch. X).

needed to carry larger crews than sailing ships and thus were considerably more expensive to run.

It was not just that the transition to steam awaited further improvement in steamship technology but that sailing ships also remained competitive as their performance continued to improve. In 1840 emigrant sailing ships took around four months to get to Australia, but by 1880 this had been reduced to less than three months (Hatton 2025, p. 458). Most of this decline was due to improvements in sailing ship technology, in particular the increase in the size of ships and the shift from wooden to iron hulls, which by providing greater strength and rigidity, supported the increase in tonnage. From 1850 the advent of clipper style ships, which were more streamlined, helped to shorten the length of voyages. Faster passages were fostered also by improved navigation, specifically sailing the so-called great circle route. This omitted calling at Cape Town or other ports and involved steering further south in the southern oceans both to reduce the distance travelled and to better exploit the westerlies of the roaring forties and higher. Indeed, advances in ship design and in navigation were complementary: larger and more robust ships, and above all the clippers, were better able to exploit the great circle route (Hatton 2024b).

Until the 1880s most emigrants travelled to Australia as steerage passengers under sail. In the three decades from 1853 almost a million arrived in Australia and New Zealand from the UK and more than half of them were assisted emigrants whose passages were partially or fully subsidised by colonial governments (Hatton 2024a). Until the 1860s most of these were recruited by agents based in the UK and sailed in ships chartered by the UK Emigration Commissioners.[4] The Commissioners relied mainly on sailing ships, which were of the highest quality, as classified in *Lloyds Register*. Although comments in their Reports suggest that they were not averse to steam, the *SS Great Britain* was not regularly chartered by the Commissioners. [5] Nevertheless some assisted emigrants travelled on it in the late 1860s and early 1870s notably with passage warrants issued by the government of Victoria and in 1873 by Queensland (Appendix 2 Table A3) . It seems likely that other steamship companies did not find it worthwhile to provide their services at the contract prices offered for charter to Australia.

There were also logistical impediments to overcome. As the number of passengers returning to Europe was much lower than the outward flow, ships needed to convert steerage space to

[4] From the early 1860s the selection of emigrants for assisted passages was transferred to agents of the Australian colonies but, until the end of the decade, they still travelled on ships chartered by the Commissioners. As Hitchins (1931, p. 206) notes, the Emigration Board of the Commission "engaged none but first-class vessels, which were fitted out according to their specifications."

[5] The Commissioners were concerned with the welfare of emigrants and their reports commented that steamships experienced lower mortality and better discipline (Emigration Commissioners 1864, p. 16; 1869, p. 18). As noted below, steerage fares on the *Great Britain* were a little higher than the contract prices offered by the Commissioners. Also, in its earlier years the Great Britain was seen as having an experimental configuration; indeed, it was never classified by *Lloyds*.

cargo for the return voyage. But the scarcity of return cargoes outside of the wool season meant that sailing ships often waited for cargoes or went on to destinations such as Shanghai, Manila and Batavia to pick up return cargoes, or engaged in trade within the region, before returning to Australia in a year-long seasonal rotation (Broeze 1978; 1989). Waiting was more difficult for steamships where the opportunity costs were higher and voyages around Asia were limited by the cost and availability of coal (Broeze, 1989, p. 12; Stammers 2013, p. 82; Elston 2011, pp. 83-91). Coal was expensive everywhere east of the Cape and bunker coal was shipped by sail from South Wales until locally sourced steam coal gradually became available.

A key factor that promoted shipping by steam from Europe to the Far East was the opening of the Suez Canal in 1869, as sailing ships could not easily pass through the Suez Canal without assistance (Rabino 1887; Fletcher 1958). The Suez Canal dramatically cut sailing times to India and (to a lesser extent) China, providing a substantial boost to international trade (Fletcher 1958; Harley 1971; Jacks et al. 2024). But emigrants continued to arrive by sail via the Cape route. This was partly because the reduction in distance to Australian ports was more modest as compared with the Far East.[6] Another reason is that passage through Suez incurred heavy tolls both on the tonnage of the ship and on the number of passengers (which disadvantaged emigrant voyages relative to freight). Two factors stimulated the use of steamships via Suez from the early 1880s. One was the award of lucrative mail contracts, where speed was of the essence, by Queensland in 1880, which also included emigrants, and by New South Wales in 1883 (Maber 1967, p. 102; Broeze 1989, p. 9-10**;** Woolcock 1986, p. 19).[7] Another was the advent of on-board refrigeration, which lent itself to shipping by steam on the shortest route, and expanded the market for return cargoes of frozen meat and chilled dairy produce and fruit (Harcourt 1995, p. 4; Arthur 2006).[8]

The experiences of steamship ventures

When the transition to steam eventually did come about, according to Broeze (1989, p. 2), it "was, like any other comparable instance of technological diffusion in transport, the product of the interaction not just of demand and supply, but also of entrepreneurial activity and innovation, as well as technological and political influence." In particular, he emphasised the "pivotal functional and organisational role played by the established shipping brokers" who either purchased their own steamers or acted as agents for other shipowners (Broeze 1989, p. 12). In the light of the technical and economic challenges, attempts to establish a regular passenger steamship service might seem hardly worthwhile until the 1880s, by which time

[6] Sailing distance to Melbourne and Sydney was reduced by about 500 nautical miles while to Indian ports the reduction was around 4000 nautical miles (Rabino, 1887, p. 526).

[7] The number of emigrants to Australia passing though the Canal increased from zero in1880 to 22,630 in 1884 (Rabino 1887, p. 527).

[8] Chilled meat was shipped from the US to the UK using ice—a method that was not feasible for the longer voyage from Australia. Refrigeration used the Bell-Coleman compressed air system, which was first brought to Australia on the *SS Strathleven* in 1879 (Arthur 2006).

those obstacles were largely overcome. Yet a number of new ventures and a few existing companies initiated services to Australia, most of which were short-lived.

To some degree there are parallels with the experiences of steamship ventures on the Atlantic route in the 1840s and 1850s, many of which failed.[9] Boyd (2020) has shown that the failures were typically steamer-only start-ups that were not well capitalised or fully insured and so the loss of one or more ships typically led to bankruptcy. One of these was the Great Western Steamship Co., which as detailed below, went bust when the grossly underinsured *Great Britain* ran aground, requiring a costly salvage operation. Those that were successful were well established sailing-ship lines, that were well networked in the migrant business, and that recognised the value of steam for the steerage trade and not just for cabin class passengers and high-value goods. Although acquiring a mail contract helped to cover the costs, it did not guarantee success, as this required regular sailings (sometimes subject to penalties for late arrival), often at times when other complementary business was scarce. In this light it is useful to examine the experience on the route to Australia.

Maber (1967) provides brief histories of the experiences of the lines that initiated passenger services by steam to Australia. Over the years from 1852 to 1875 (when the *Great Britain* was in service to Australia) 24 shipping lines planned or started steamship services (for details, see Appendix 1). Of these, 17 operated for less than five years; most of them managed only a handful of sailings, and two none at all. Many of the lines were newly established, and were often initiated by winning mail contracts, but found that the ships they had bought or chartered were unreliable, slow, or incurred costs (notably of coal) that were higher, and revenues that were lower, than expected. A significant number fit Boyd's characterisation of having little or no history of providing sailing ship services, and consequently lacking established networks of brokers and agents. An extreme example is the European and Australian Royal Mail Co., a relatively new concern, which in 1856 won an Admiralty contract for a service via the Suez land bridge, but was "unprepared to meet its obligations", "lacked organisation or facilities east of Suez", and by 1857 was "hopelessly insolvent" (Maber 1967, p. 65-66). From 1866 three new lines in succession initiated steamship sailings across the Pacific to link with services from Europe across the Atlantic and overland to Panama or San Francisco. Even with mail subsidies these were short-lived until the service was taken over and run from 1875 to 1885 by the more established Pacific Mail Steamship Co.

Well-known lines with considerable experience in passenger services to Australia by sail had mixed fortunes. The Black Ball Line linked up with the Eagle Line (operated by Gibbs, Bright and Co.) and invested in one steamer in 1863 but, due to declining business and entanglement in financial crisis, did not invest further. Similarly, the White Star Line acquired one steamer which made three voyages in 1863 to 1866, but also faced diminishing traffic and liquidated its assets in 1867. Devitt and Moore, well-established shipbrokers and owners of clippers in

[9] The experiences of shipping lines on the Atlantic are described by Bonsor (1955) and Fox (2003), and the trials and tribulations of early steamship enterprise and development are recounted in detail by Smith (2013).

the Australian trade, invested in a steamer to carry steerage passengers, goods, and prospectively mail, via the Cape in 1870 but abandoned steam after their ship was wrecked on the return from its first voyage.[10] One company that made a partial transition to steam was Money Wigram & Co., which operated voyages from 1864 but found it increasingly unprofitable and, in the face of entry by the Orient Line (see below), shifted to cargo. Only the Liverpool and Australia Steam Navigation Co., the owners of the *Great Britain,* managed to sustain a steamer service for bulk goods and passengers in the decades before 1880, mainly with that one ship (more on which below).

By far most successful steamship line in the decades before 1880 was the Peninsular and Orient Line (P&O) originally founded in 1837. The company was awarded mail contracts on routes extending progressively through the Mediterranean to Alexandria, then overland to Suez and from there by paddle steamer to India via Aden and Point de Galle (Ceylon). In 1852 a new contract added a leg to Australia via Singapore from Point de Galle. This service proved unprofitable partly because of the high cost of coal in Australia and, with the demand for shipping for the Crimean war, the service was suspended in 1854. The company resumed the service to Australia via Aden and Mauritius with a new contract in 1858 but suffered breakdowns and coal shortages and re-routed from Point de Galle.[11] From 1873 the P&O Line regularly ran steamers through the Suez Canal, but with the service to Australia still via transhipment at Point de Galle, until direct sailings via Colombo began in 1881.[12] Throughout these years the P&O ships were progressively upgraded from wooden paddle steamers to larger iron screw steamers with compound engines. The P&O continued to carry mail, high-value goods, first and second class passengers but no steerage passengers and so it ignored the emigrant trade.[13]

According to Broeze (1989, p. 8) the breakthrough "was achieved in 1877 when (after some experimental sailings) the Orient Line came into being as the result of two of London's most prominent shipping brokers in the Australian trade, Anderson, Anderson & Co. and F. Green & Co., joining forces with the Pacific Steam Navigation Company. Anderson's and Green's were also owners of sailing ships, but it was their pivotal position and function as brokers,

[10] Breslin (1992, p. 34) notes that, unlike the typical auxiliary steamer, the ship, *Queen of the Thames*, made the outward voyage entirely under steam. Devitt and Moore later merged with F. Green and Co., which became partners in the Orient Line.

[11] In the interim the contract had been awarded in 1856 to the European and Australian Royal Mail Co, as noted above.

[12] In 1874 the UK government withdrew its mail subsidy for the final leg, which was taken over by the government of Victoria (Maber 1867, p. 8). The government of New South Wales preferred the route via San Francisco, but as Broeze (1989, p. 8) noted "the transpacific route would, until the opening of the Panama Canal, never be able to be a significant carrier of trade goods or migrants, and any advantages gained through its adoption could not, in consequence, be more than temporary and partial."

[13] As Harcourt (2006, p. 193) shows, without the mail subsidies, the P&O business would have suffered a loss in most years from 1846 to 1868. At the P&O's annual general meeting in 1863 a question was asked about the policy of carrying only first class passengers. In response, managing director Anderson commented that 'it would be disagreeable for the higher class of folks to be elbowed by such vulgar people' (quoted in Harcourt 2006, p. 206).

mediating between and intimately knowing both the demand and supply sides of the Australian trade, which gave them the necessary knowledge and connections to risk the introduction of a regular steam service - in addition to and not instead of, it should be stressed, the sailing ship traffic, which they continued to handle." While the initial focus was on goods, from 1880 the Orient Line steamships could accommodate around 300 steerage (third class) passengers (Maber 1967, p. 101-2). By that time these were ships exceeding 4,000 tons with advanced compound engines that relied little on sail. They also carried frozen meat and dairy exports on return voyages via Suez. Initially, the Orient Line sailed outward via the Cape but, with the award of a mail contract (shared with the P&O), in 1883 it shifted to using the Suez route both ways.

The original establishment of the Orient line was quickly followed by others in response. In 1880 the British India Steam Navigation Co. was awarded a contract for mail and emigrants by the Queensland government for a direct service from London to Brisbane (Woolcock 1986, p. 19). And in what Broeze (1989, p. 11) describes as a 'major impetus', in 1882 Geo. Thompson Co. (the Aberdeen Line) introduced the ship *Aberdeen* with a triple expansion engine, sailing outward via the Cape and return via Suez. "With this vessel they specifically aimed at the lower end of the market, which they had been serving for a long time with their large fleet of sailing ships. Apart from forty-five first-class passengers the *Aberdeen* could carry up to 650 migrants" (Broeze, 1989, p. 11). But they did not provide a regular scheduled service until the 1890s. Meanwhile Houlder Bros & Co., shipping agents, who operated sailing ships and chartered a few steamers to Australia, established a regular steamship service via the Cape from 1879 (Maber 1967, p. 157-9).

As the experiences of steamship lines outlined here illustrate, there was very little success in establishing regular passenger steamship services for the bulk of emigrants to Australia before 1880. Business networks were important but did not necessarily result in the transition from sail to steam until the end of the 1870s, by which time shipping technology had vastly improved. But there is one outstanding exception—the *SS Great Britain*, which as noted above, made regular voyages with passengers from Liverpool to Melbourne that commenced quarter of a century before regular emigrant services by steam were established by other companies. In the following sections I examine the history of this remarkable ship.

The story of the *SS Great Britain*

The story of the *SS Great Britain* has been told many times and will be recounted only briefly here.[14] It is rightly famous as a pioneer steamship, built by Isambard Kingdom Brunel for the Great Western Steamship Co. The company was founded in 1836 with the aim of establishing a regular steamship service across the Atlantic. Its first ship, the *PS Great Western*, built in Bristol, was a wooden-hulled paddle steamer of 1,340 gross tons, also designed by Brunel. On

[14] These accounts include Farr (1965), Rowland (1970), O'Callaghan (1971), Corlett (1990), Fogg (2002) and Doe (2019).

its first voyage in 1838 it made a record time of 15 days and 5 hours from Liverpool to New York.[15] Although the company had failed to gain a profitable mail contract (which in 1841 went to Cunard), from 1838 to 1844 the *Great Western* made 34 voyages to New York averaging 15 days 12 hours outward and 13 days 9 hours return (Corlett 1990, p. 13).[16] It had been the company's original intention to operate more ships and so in 1838 plans were laid to build a second ship, also designed by Brunel.

At the design stage, the specification of the *Great Britain* became ever more ambitious. At 3,443 tons, it was much larger than other any ship of the day, with a length of 322 feet and a beam of 50.5 feet. When launched in 1843, the ship had six masts and was powered by a 1,000 horsepower steam engine. The major innovations were a hull constructed of iron rather than wood and propulsion by screw propeller rather than paddle wheels, and it also incorporated numerous other advances in marine engineering.[17] But the costs escalated, ultimately to more than three times that of the *Great Western*, which given its modest revenues, the Great Western Steamship Co. could ill afford.

The *Great Britain* made two voyages from Liverpool to New York in 1845 with few passengers, making respectable times, but returned from its second voyage largely under sail due to a broken propeller. It was then laid up for alterations: reducing the masts from six to five, replacing the propeller and improving the boilers. After the refit, it made two further voyages in 1846 to New York. On September 22nd 1846 it departed again but later that day it ran aground on the Northern Irish coast at Dundrum Bay, where it languished for eleven months before being re-floated, patched up, and towed back to Liverpool. The salvage operation was costly and to refit the ship would be even more costly.[18] Great Western Steamship Co. had been forced to sell *Great Western* in 1847 and, with no other revenues, it did not have the resources to cover the cost of extensive repairs, so it put the *Great Britain* up for sale and subsequently went into liquidation. The ship was eventually sold in 1850, for less than one sixth of its original cost, to Gibbs, Bright and Co. who had been the shipping agents for the *Great Western*.

Under new ownership the *Great Britain* underwent a major rebuild that involved reducing the masts to four, fitting smaller engines, adding an upper deckhouse and increasing the space allocated to cargo and passengers. After an uneventful return voyage to New York, in August 1852, the ship departed for its first voyage to Melbourne via Cape town with 654 passengers. On the outward trip the ship ran low on coal and, before reaching the Cape, it turned back to

[15] In a contest to be the first steamship to cross the Atlantic from east to west, on April 23rd 1838, the *SS Sirius* (703 tons) arrived 3½ hours earlier but took four days longer than the *Great Western*, which had been delayed by a fire on board (Farr, 1965, p. 10).

[16] Even without a mail contract the *Great Western* did turn an operating profit, making £1,405 a round trip in 1840-1 (Boyd 2020, p. 8). In 1843 receipts were £33,400 and expenditure £25,600 (Corlett, 1990, p. 83).

[17] These included the riveting and plates, longitudinal stiffening of the bottom, multiple bulkheads, bilge keels, rudder design, hinged masts with wire ropes, and iron lifeboats (for details, see Corlett 1990; Allington 1998).

[18] The salvage operation cost around £34,000 (Fox 2003, p. 155).

St Helena to refuel, eventually arriving at Melbourne after 82 days, mainly under sail. After returning via the Cape the ship was again refitted, with the masts reduced to three (all square rigged) and the screw propeller replaced. On its second voyage to Australia the *SS Great Britain* made the outward voyage in 67 days, stopping at St Vincent (Cape Verde) for coal and returning, as in subsequent voyages, via Cape Horn. After another successful voyage to Melbourne it was commissioned for service as a troop ship for the Crimean War.

After serving as a troopship in 1855-6 the *Great Britain* underwent yet another extensive refit. This time it was fitted with three much heavier masts with longer yards and a poop-deck added. After one further voyage to Melbourne, the ship was again used to convey troops, this time in response to the Indian Mutiny. Following the reconversion of the interior, the ship made one voyage to New York followed by one to Melbourne and another to New York. From 1858 to 1875 the ship then made 28 round trips to Australia. Over its 32 outward voyages to Australia the *Great Britain* carried a total of 15,885 passengers. On its final return to Liverpool in 1876 the ship was laid up but did not find a buyer until 1881. With the removal of the engines, it was converted to sail only and used to ship coal to San Francisco via Cape Horn. On its third voyage in 1886 it was dis-masted in a hurricane off Cape Horn and sustained structural damage and so it put back to the Falkland Islands where it was to be abandoned by the owners. In 1970 what remained of the ship was mounted on a pontoon and towed back to Bristol, where it was placed in the dock in which it was built, restored largely to its 1843 design, and opened as a tourist attraction.

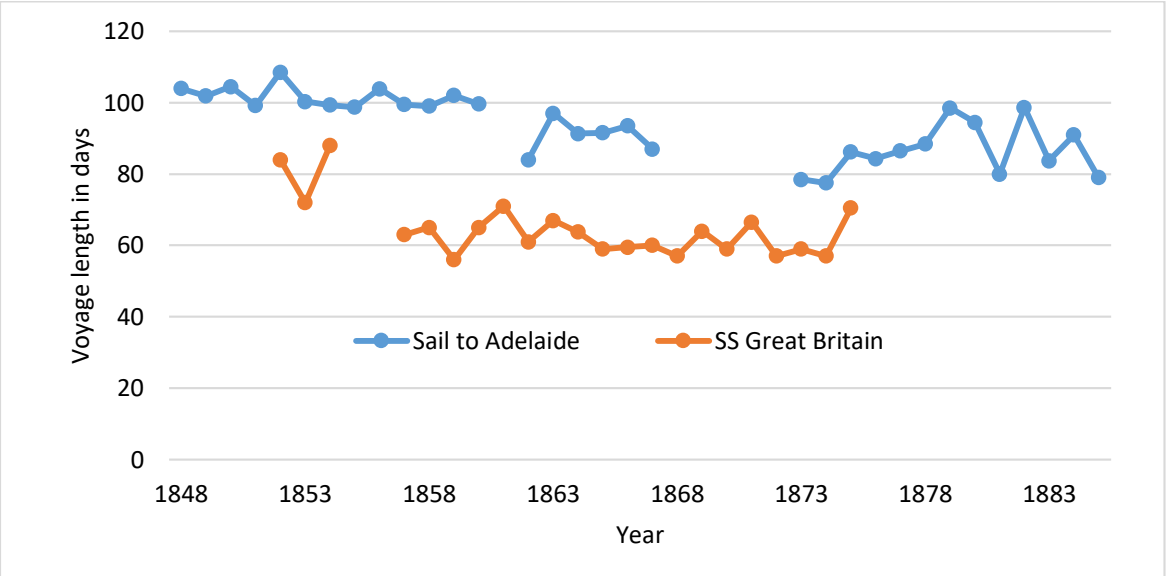
The performance of the *SS Great Britain*

According to Blainey (1966, p. 209) the *Great Britain* "was famous more for reliability and longevity than for speed." Speed was important not only because this was widely reported in the press and seen as an indicator quality but also because a ship could make more voyages over a given number of years. For the shipowner it saved on the daily maintenance cost of passengers, and for passengers, shorter voyages saved on foregone earnings. The *Great Britain* was not a great success on the Atlantic route, at least not in terms of speed. Its average westward crossing although considerably shorter than the average sailing ship, at 16.4 days, was no better than the *Great Western* and slower than the Cunard steamers (Rowland 1971, p. 68-9). But it did much better on the Australian run in competition with sail.

Figure 1 compares average voyage durations of the *Great Britain* to Melbourne with those of sailing ships carrying assisted emigrants from the UK to Adelaide. Across the years from 1848 to 1885 the latter took 93 days on average whereas the *Great Britain* from 1852 to 1875 averaged 65 days. The gap would be smaller in comparison with the fastest clippers of the day. Thus the justly famous *Marco Polo* made the voyage to Melbourne in 74 days (10 days less than the interrupted voyage of *Great Britain* the same year) and others followed with even faster times. But from the late 1850s the *Great Britain* was consistently faster than the

clippers, and a lot faster than the average emigrant sailing ship, although by a margin that decreased over time.[19]

Figure 1: Voyage durations of the *SS Great Britain* and of sailing ships to Adelaide



Notes: Voyage durations by departure years calculated as the difference between arrival and departure dates. For the *SS Great Britain*, ten of the years represent two voyages, the others just one. *Sources*: For sailing ships to Adelaide: Hatton (2024b); for the *SS Great Britain*: https://globalstories.ssgreatbritain.org/_/voyages/.

Such comparisons suggest that the *Great Britain's* advantage was simply that of steam over sail. But that would overlook the fact that, like all steamships of the day, it was partly powered by sail. Indeed, as a result of the series of refits noted above, it went from being a steamship with auxiliary sail to a sailing ship with auxiliary steam (Corlett 1990, p. 54; Doe 2019, p. 87). The increasing importance of sail might seem surprising when the number of masts was progressively reduced from six to three. But of the original six, only the mainmast was square-rigged while the other five were rigged fore and aft (lateen rigged) (Figure 2a). These were supplementary sails on masts that carried less sail and were hinged so that their angle could be adjusted (and thus they were anchored at deck-level rather than at the keel).[20] In the 1853 refit when the number of masts was reduced to three, these were fixed and all square rigged after the fashion of the clippers. Even though the number of masts was reduced, square rigging increased the area of sail per mast, as compared to lateen rigging, which typically made ships more manoeuvrable but slower in a following wind. This was designed to take full advantage of the westerlies on the round trip to Australia. After its third voyage to Australia and service to the Crimea, still heavier masts were installed and the yards were substantially

[19] Lubbock (1922, p. 273) gives times to Melbourne of Liverpool clippers and Blackwall frigates in 1860 of 85 and 86 days respectively. The *Great Britain's* time in 1860 was 65 days.

[20] The supplementary sails were hinged so that they could be raked; they could not be lowered to deck level but only to about 40 degrees from vertical.

extended to increase the sail area to double that of 1843 (Figure 2b).[21] In this regard, it is notable that the average time to Melbourne decreased from 81 days in 1852-4 to 62 in 1857-75.[22]

Similarly, the engines were altered in a number of refits. The engines fitted in 1851 were smaller but more efficient with boiler pressure of 10lb per square inch and nominal horsepower of 500. This was half the nominal horsepower of the original engines but double the boiler pressure, and the indicated horsepower was only a little less. It could propel the ship at about 11 knots under steam alone and would require about 40 tons of coal per day (two thirds that of the original engine (Corlett, 1990, p. 79)). The *Great Britain* carried around 1,200 tons of coal, and so without stopping for coal, it could steam for 30 days at most. In the 1857 refit a new stern frame was installed so that the propeller could be lifted out of the water in order to reduce drag when under sail alone (Corlett 1990, p. 138). Thus, as with all auxiliary steamers of the day, steam was only used part of the time. On a voyage to Melbourne in 1861, steam power was used for 43 percent of the time and the ship averaged upwards of 200 miles per day under sail alone, with a fastest day of 315 miles in the roaring forties (Rowland 1971, p. 105). On a return voyage in 1860 the ship sailed under canvas alone for 52.8 percent of the time, used both sail and steam for 31.7 percent, and steam only for just 15.5 percent (Corlett 1990, p. 141).[23]

The transformation of the *Great Britain* is illustrated in Figure 2 which compares photographs taken in 1844 and 1875. Figure 2a is the famous picture of the *Great Britain* in Bristol's floating harbour shortly after its launch, attributed to pioneer of photography Henry Fox Talbot. It shows the original six masts, only the second being square rigged, the single large funnel and very little superstructure. In Figure 2b the *Great Britain* is pictured at Gravesend in 1875. It looks a very different ship, with three tall, heavy masts all square rigged in the manner of the clippers, with a smaller funnel and more superstructure. Indeed, it had become the epitome of a clipper ship.

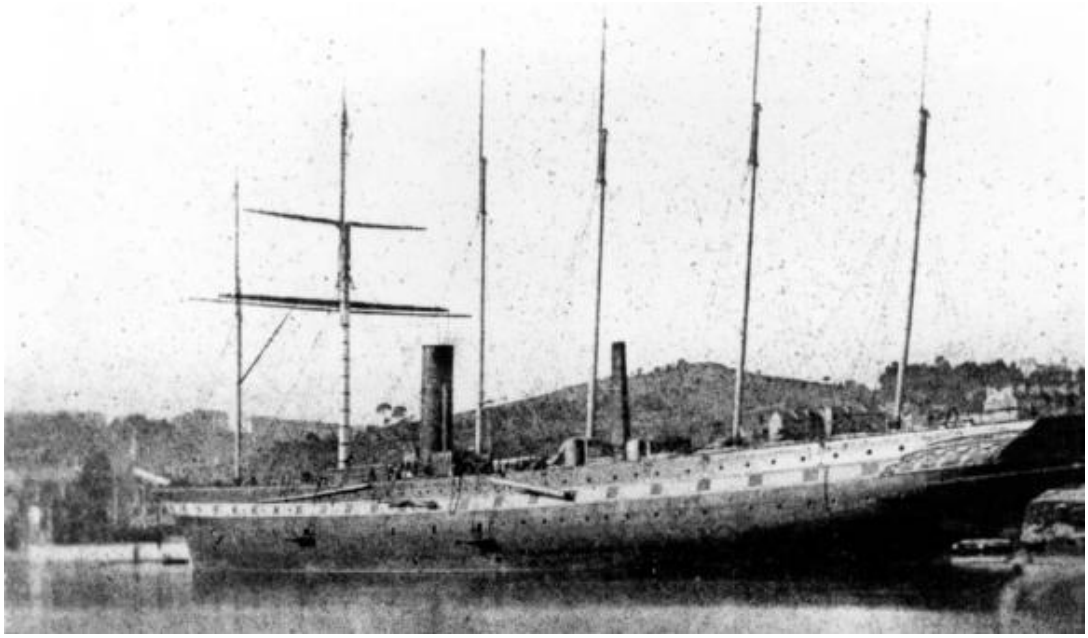
[21] The new mainmast was constructed of four oak trees banded together; it was 95 feet tall, 43 inches in diameter, weighted 18 tons and had a mainyard of 106 feet (Fogg, 2002, p. 97; Corlett 1990, p. 138). The original sail area was 16,000 square feet; by 1857 this had been increased to 33,000 square feet (Corlett 1990, pp. 74, 138).

[22] Of the first voyage to Melbourne, when it ran short of coal, Corlett (1990, p. 134) remarks that: "The *Great Britain* was still a steamship with auxiliary sail, and the route chosen was that of a steamship. The attempt to steam into the trade winds and the Benguela current had proved the ship to be underpowered and too extravagant on coal to do this. Furthermore, the route home westwards had meant steaming against the prevailing winds much of the way to Cape Town. At least twenty days had to be cut off the running time each way and stops could not be afforded." It was this experience that prompted the refits of 1853 and 1857 and the subsequent return route around Cape Horn.

[23] Like other screw steamers, the *Great Britain* had a tendency to roll in heavy seas when under steam alone, unlike paddle steamers where the paddles helped to stabilise the sideways movement. Using sail mitigated this tendency and improved the comfort of passengers (Corlett 1990, p. 130; Smith 2013, p. 367).

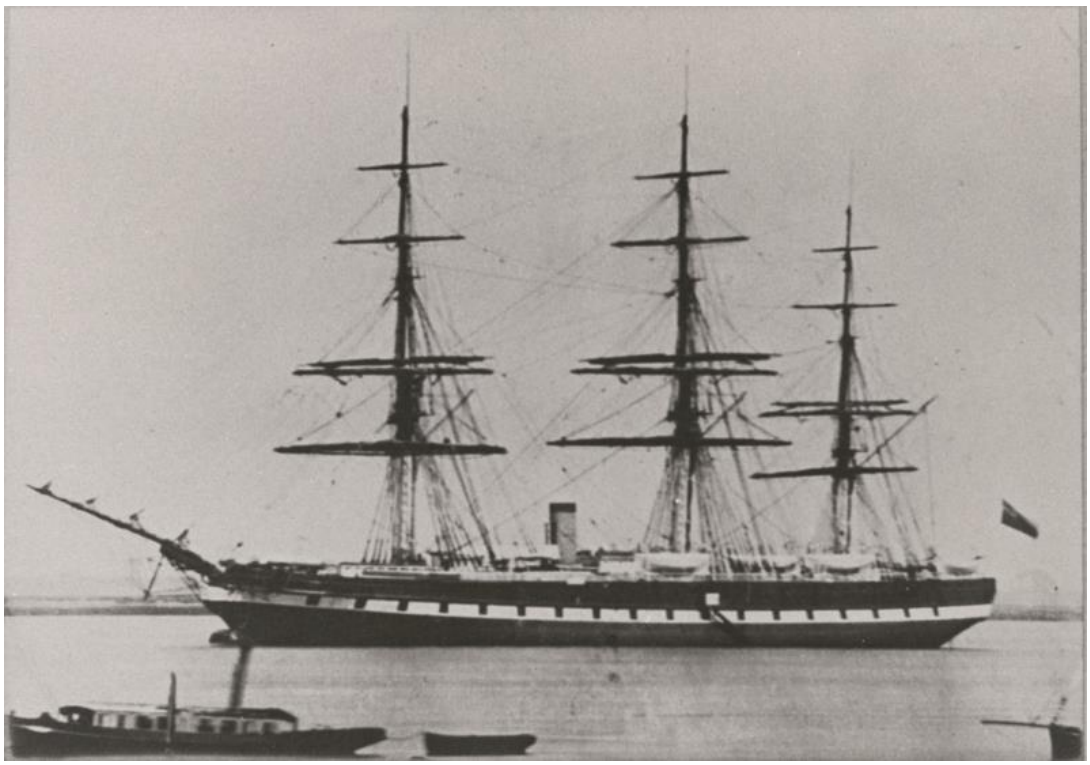
Figure 2: The transformation of the SS Great Britain

Figure 2a: *SS Great Britain* in 1844



Note: The *SS Great Britain* at Bristol in 1844; photograph attributed to William Henry Fox Talbot.
Source: National Maritime Museum, Greenwich.

Figure 2b: *SS Great Britain* in 1875



Note: *SS Great Britain* at Gravesend in 1875.
Source: National Maritime Museum, Greenwich.

The *Great Britain's* advantage over the average sailing ship could be accounted for by the fact that steam-assisted sailing, even with modest steam power, was faster than sail alone. In particular, the use of steam could make faster passage through the equatorial doldrums and follow a more direct route. But as shown in Appendix 4 the *Great Britain* followed a track similar to those of 290 sailing ships from Europe to Melbourne in 1854-62. This involved sailing southwest towards the coast of Brazil before looping southeast to pick up the roaring forties rather than following the more easterly steamship route. As a sailing ship the *Great Britain* had an important advantage: for its day, it was a very large ship. At over 3000 tons it was three times the average tonnage of emigrant sailing ships of the 1850s and it was around twice as long.[24] The potential speed of a ship is a positive function of its tonnage and, more specifically, of its length at the waterline.[25] One estimate suggests that an increase of 1000 tons in the size of sailing ships would reduce the voyage time from the UK to Australia by around 8 days (Hatton 2024b, Tables 2 and 6). And despite predating most of the clippers, the *Great Britain* shared some features of their hull design and so under sail alone it could travel just as fast (Corlett 1990, pp. 96, 140).

Why did the SS Great Britain succeed were others failed?

Why did the *SS Great Britain* manage to sustain a regular service to Australia for almost quarter of a century before this was achieved by other shipping lines? This is all the more surprising as the company that ran it (the Liverpool and Australian Navigation Co.) had no ongoing mail contract—something that had triggered other steamship entrants and sustained a few of them, especially after 1880. Also, in contrast with some of the best known sailing ships, the *Great Britain* was not chartered by the UK Emigration Commissioners to carry a full roster of assisted emigrants. I first consider the ship itself and then, in the next section, the company that operated it.

The *Great Britain* had to compete in the market for shipping goods and passengers. One important feature was the reputation of the ship, which for such a long voyage, was important in attracting (or deterring) business, and especially for a steamship in the 1850s when steam to Australia was still experimental. On its initial voyages to New York the *Great Britain* attracted huge interest and as many as 1,000 visitors per day came on board to view it while in port (Rowland 1971, p. 69). But relatively few were willing to travel across the Atlantic in such an experimental ship and over four voyages in 1845-6 it averaged 71 passengers outward

[24] The average size of a sample of the 290 sailing ships from Europe arriving in Melbourne in 1854-62 is 1,041 tons (Hatton 2024b, Table 5). The first ship to rival the *Great Britain* in size was the 3,438 ton *Himalaya* launched in 1853 for the P&O Line but found to be uneconomic and sold in 1854 to the Royal Navy.

[25] The so-called hull speed of a ship is the maximum speed that the hull can travel through the water before meeting a virtual ceiling due to steeply rising resistance or drag. This is when the bow wave, which lengthens and heightens with the speed of the ship, merges into the stern wave. This point (in knots) is approximated as: $1.34 \times \sqrt{L}$, where L is the length of the ship at the waterline in feet. This means that hull speed is a positive function of length and, below that threshold, the longer the ship the lower the resistance at any given speed (or the faster the speed for a given degree of resistance).

and just 31 return, despite the fact that, unlike the *Great Western,* it offered three different fares. Notwithstanding its grounding at Dundrum Bay, it subsequently established a good reputation for safety.[26] On its first voyage to Australia it carried 654 passengers and was given a tumultuous welcome in Melbourne.[27] Its reputation for speed, reliability and (relative) comfort was consolidated and enhanced by its subsequent record. This was due in no small part to the way in which the ship had been adapted from sail-assisted steam to steam-assisted sail.

Also important is the way in which the carrying capacity of the ship was rearranged and increased, transforming it from a luxury liner to an emigrant/cargo ship. In its original form, the *Great Britain* had accommodation for 252 berthed passengers (first and second class) plus around 100 third class, space for 1,200 tons of cargo, and bunker capacity for 1,100 tons of coal. After the 1851 rebuild, which added a large deckhouse, it had accommodation for 730 passengers, 50 in first class but most in third and steerage and its cargo capacity almost doubled, largely by replacing cabins and saloons (Rowland 1971, p. 91; Corlett 1990, p. 124). Although in the 1857 refit the deckhouse was extended to accommodate more first class passengers with other classes slightly reduced, for the rest of its Australian voyages, the ship retained its capacity for goods and steerage passengers.

It might be expected that the *Great Britain* could command higher fares for a faster and more reliable service (Stammers 2013, p. 48). But the steerage fares were only 10 to 20 percent higher than the pure sailing ships. In 1871 the top fare to Melbourne, first class, after saloon, was 55 to 70 guineas but the steerage fare was 15-16 guineas, at a time when prices for steerage passengers on sailing ships was £14 and the contract price for assisted emigrants was £13 15s. Although it was never chartered as an emigrant ship by the UK Emigration Commissioners, the Victorian government gave it a stamp of approval by booking passages for some assisted emigrants. Just as important, the ship was able to attract passengers for the return voyage, which until the 1880s was a challenge for all ships, and especially for steamers. On the 32 return voyages the average number of passengers was three-quarters of the outward flow during a period when the Australia-wide return passenger flow was probably less than 20 percent.

Not only did the *Great Britain* prove popular among passengers, its speed and reliability attracted a variety of cargo. For example, on its return voyage to Liverpool in 1855 it carried, in addition to 245 passengers, 165 boxes of gold dust, specie and jewellery, 642 bales of wool, 120 casks of tallow, 20 bales of leather, 105 packages of general merchandise, 3 bales of

[26] Trust in steamers had improved since the 1840s. The fact that the *Great Britain's* hull was still intact after languishing for eleven months at the mercy of the tides at Dundrum Bay may even have been reassuring. Also, it could use its engines steam away from hazards like the massive iceberg that allegedly embayed the clipper *Guiding Star,* which was lost on the great circle route in in 1855 (Corlett 1990, p. 136; Loney and Stone 2000, pp. 49, 112; Mival 2015).

[27] The ship spent two months at Melbourne unable to find labour to load cargo because the gold rush (Maber 1967, p. 46). During that time, over 4,000 people paid a shilling each to take a tour of the ship.

"Australian goods", 1 case of silk, as well as 97 bags of letters and newspapers (Hollett 1986, p. 63).

One reason that many of the initial steam ventures failed was that steamships were costly to build and costly to run. With regard to the cost of capital, the *Great Britain* was purchased in 1850 for just £18,000, as compared with its original construction cost of £117,295, not including £54,412 for the building establishment and altering the lock gates (Farr, 1965, p. 6). Even though the post-Dundrum restoration would have been costly, as the ship had been gutted in the process of recovery, nevertheless the overall cost to the new owners was probably less than half of its original construction cost (see Appendix 2). But running costs would be greater than for sailing ships, as steamships required an engine room crew in addition to deck and passenger service crews. On its voyages to Melbourne the *Great Britain* carried an average crew of 140 as compared with around 39 for sailing ships in 1858 to 1867. But the comparison is much closer when scaled by the size of ship: 21 tons of ship per crew member on the *Great Britain* compared with 26 tons per crew member on sailing ships.[28] Thus scale was important: the *Great Britain* benefitted from scale economies while the fixed cost to the owners of acquiring and refitting it was a fraction of what it had originally cost to build. Smaller steamships that were being built in the 1850s would have cost about the same to build as the *Great Britain* cost to buy and refit but would have required more crew per ton of ship.

The cost of coal was a perennial problem that was widely cited as a reason for the failure of steamship ventures, both because the early steam engines consumed so much of it but also because of the high price of coal east of the Cape. In Australia steam coal which came from the mines of Newcastle in New South Wales was three or four times the price in England.[29] It was particularly expensive in the 1850s as demand increased and mining labour was in short supply due to the gold rush. On its first two voyages, the *Great Britain* stopped for coal both outward and on the return.[30] But after the 1857 refit it rarely stopped *en-route* for coal as it was able to economise by travelling most of the way under sail. Even when steam was used, not all of its six boilers were always fired.

Managing the *SS Great Britain*

Gibbs, Bright and Co., established in 1818 and based in Bristol and Liverpool, were shipping and insurance agents and managers of the Eagle Line of packets to Australia, which was

[28] The data for medians of crew and tons per crew member for 77 sailing ships carrying emigrants from the UK and arriving in Sydney from 1858 to 1867 is sampled from the lists at: https://www.marinersandships.com.au/.
[29] It has been suggested that this was one motivation for Brunel's third ship the giant *Great Eastern* (18,915 tons and equipped with both paddle wheels and screw), which was originally intended to carry enough coal for the round trip to Australia without refuelling (Doe 2018, p 61). In the event the *Great Eastern* was dogged with misfortune and never sailed to Australia.
[30] On the second return voyage, via Cape Horn, the *Great Britain* stopped at the Falklands to pick up coal that had been shipped out from South Wales.

launched with four sailing ships in 1850.[31] They also had commercial interests in the USA, Canada, South America, the Far East and Australia. But they had no local office until Charles Edward Bright arrived to set up and Australian branch in 1853 (Bright Bros. and Co.). Yet its management of the Eagle Line of sailing packets meant that it had some experience of shipping to Australia. The company also had a commercial network which helped it to secure passengers and freight for the *Great Britain*. In 1854 the Liverpool & Australian Steam Navigation Co. was created as a joint stock subsidiary of Gibbs, Bright and Co. to manage the steamship service, to which the *Great Britain* was transferred (Corlett 1990, p. 136).

The company had served as agents for the Great Western Steamship Co. of which one of its partners (Robert Bright) had been a director. So the directors were well acquainted with the *Great Western* and the *Great Britain* (Doe 2019, p. 129). The gold boom stimulated a search for shipping capacity to Australia and the directors saw an opportunity to bring a large ship into the Australian trade. As noted above, Gibbs Bright and Co. purchased the *Great Britain* for a fraction of what it cost to build. The company also had the acuity to see that the ship would have to be extensively refitted to make it suitable for goods and emigrants, including large steerage capacity, for the Australian run. Indeed, the refits of 1851, 1853 and 1857, noted above, were each steps in that direction. Having built a solid reputation for reliability the ship could yield positive if unspectacular profits on most of its subsequent voyages (see Appendix 3).

A key element of the company's strategy is illustrated by the refit of 1856-7, which was designed to render it "a most perfect Clipper Sailing Vessel, and altogether independent of her steam power" (see Appendix 2). It is also illustrated by the introduction of another steamship, initially as a substitute for the *Great Britain* during the Crimean War and later as its consort. In 1854 Gibbs, Bright and Co. purchased from a bankrupt builder an incomplete iron sailing ship and had it converted into a steamer. The *Royal Charter* echoes some features of the *Great Britain*. It was a large ship, 2,719 tons and 335 feet in length, purchased at a bargain price, and then fitted out for the Australian run. It was a screw steamer with a 200 horsepower engine and full sailing rig, providing accommodation for 600 passengers (Maber 1967, p. 47; Corlett 1990, p. 194). The small engine had only 40 percent of the power of the *Great Britain* and so it travelled under sail for much of the time but nevertheless made good times to Melbourne of around 60 days. Thus steam was even less important than for the *Great Britain*, which saved on coal and cargo space, but it ended in disaster. On its sixth homeward voyage in 1859 the *Royal Charter* was wrecked on the coast of Anglesey with the loss of 454 lives.[32] This tragedy shook the company but did not ruin it, as the ship was adequately insured.

[31] These ships, *Albatross*, *Salacia*, *Petrel* and *Condor* were clippers of 1,000 to 1,500 tons (Doe, 2019, p. 123).

[32] In a violent storm, the ship's engines were not strong enough to pull it away from the shore, and so it dropped anchor, but the cables broke, rigging from the fallen masts fouled the screw, and it was driven on to the rocks (Loney and Stone 2002, pp.121-3). There is some suggestion from contemporary accounts that, in the severe storm that blew up, the captain should have stood out to sea rather than keeping close to shore with a beacon calling for a pilot to attend (Fowler, 1859, pp. 49-52).

This contrasts with the experience of the Great Western Steamship Co., which had massively underinsured the *Great Britain*, so that the shipwreck at Dundrum Bay led to its bankruptcy.[33]

An important element in the commercial success of the *Great Britain* was the energy and enterprise of the local agent, Bright Bros. and Co., in vigorously promoting the ship for passengers and freight, building networks and expanding their activities. Initially, in 1852, they managed to secure coal for the *Great Britain* from local sources.[34] And they gradually expanded their agency to other shipping lines, for example in 1859 they took over as agents for Money Wigram's Blackwall line of clipper ships. A measure of their enterprise is that (reverting to the name Gibbs Bright & Co.) their interests expanded from shipping agents and insurance into mining, building trades, pastoral and merchant banking (Elston 2011, Ch. 8).[35]

From the late 1850s commercial conditions became more difficult as the gold boom receded and passenger numbers diminished. In 1858, Gibbs, Bright and Co. entered into an agreement with the Black Ball Line of James Baines and Co. to operate their two steamers jointly, an agreement that lasted until the latter's demise in 1871. Thereafter the *Great Britain* kept going even though revenues had fallen as the total supply of shipping capacity increased and the emigrant trade declined. One reason is that the ship was still popular and making good times to and from Australia, while requiring little maintenance.[36] Another is that Gibbs Bright and Co. continued to work hard to attract passengers and cargoes until the *Great Britain* was chartered for its last Australian voyage in 1875-6. Indeed, the adaptability of the ship to different uses, and the owners to find those uses, were important reasons for its longevity.

Finally, while success and longevity of the *Great Britain* owed much to the size, strength and durability of the ship itself, there is clear evidence of shrewd management by its owners and not a little good luck. In the early 1850s it was able to take advantage of the gold rush boom to earn good revenues while countering the high cost of coal, and adapting and rerouting the ship. This was followed by highly profitable service as a troop ship to Crimea and India, which provided both the opportunity and helpful finance for further refits for the Australian route. Entry into a joint enterprise with Black Ball Line in 1858-67 also helped to sustain passenger demand. And under a popular and able captain, John Grey, for most of its service to Australia, the ship avoided serious and costly mishaps such as befell the *Royal Charter*.

Conclusion

[33] The Great Western Steamship Co. insured the *Great Britain* for just £17,000, partly because of the high cost of insuring a ship which, due to its experimental nature, was not classified by Lloyds (Corlett 1990, p. 119; Doe 2019, p. 76)

[34] 1,620 tons of coal was obtained from J. and A. Brown of Burwood and Morpeth and J. Donaldson of Newcastle (*Maitland Mercury and Hunter River General Advertiser*, 22 December 1852, p. 3).

[35] Charles Edward Bright married the daughter of the Governor of Victoria, became president of the Melbourne Chamber of Commerce, and vigorously promoted widening of the Yarra and improvements to Melbourne harbour.

[36] From 1857 to 1876 it underwent only minor refits—in 1863 and 1872.

The transition from sail to steam for the bulk transport of passengers and freight from Europe to Australia took place almost two decades later than on the route across the Atlantic. The reasons for this have been widely rehearsed and they include the inefficiency of the early steam engines and the resulting high costs of steam as compared with sail. Principal among these are the capital costs and the additional costs of labour and coal. They also included having the appropriate business organisation and the foresight to adapt to steam-assisted sail on the Australian route. Indeed, the string of failed steamship ventures from the early 1850s to the late 1870s what makes the pioneering history of the *Great Britain* stand out all the more strikingly. The ship, cheaply purchased as a virtual wreck, was converted from a luxury liner to a large carrier of bulk passengers and freight. A key point emphasised here is that in the series of refits the *Great Britain* became a fast clipper-style sailing ship with only modest steam power, which made it uniquely fitted for the Australian run. It is worth noting that the *Great Britain* that is now on display in Bristol has been extensively restored to the 1843 version, which reflects Brunel's vision, rather than the post-1857 version which brought it commercial success over two decades. This success owed much to the business acumen of its owners, Gibbs, Bright and Co, together with an element of luck.

References

Allington, P. (1998), "The Sailing Rig of the SS Great Britain," *Mariner's Mirror*, 84 (4), pp. 444-457.

Arthur, I. (2006), "Shipboard Refrigeration and the Beginnings of the Frozen Meat Trade," *Journal of the Royal Australian Historical Society*, 91 (1), pp. 63-82.

Blainey, G. (1966), *The Tyranny of Distance: How Distance Shaped Australia's History,* Melbourne: Sun Books.

Bonsor, N. R. P. (1955), *North Atlantic Seaway: An Illustrated History of the Passenger Services linking the Old World and the New*, Prescot, Lancs: T. Stephenson & Sons.

Boyd, J. (2020), "Mechanising Migration: Transnational Relationships, Business Structure and Diffusing Steam on the Atlantic," *International Journal of Maritime History*, 32 (1), pp. 3–22.

Breslin, B. (1992), "The "Queen of the Thames" - Technology on Trial?" *The Great Circle*, 14 (1), pp. 31-48.

Broeze, F. J. A. (1978), "British Intercontinental Shipping and Australia, 1813-1850," *Journal of Transport History*, 4(4), pp. 189-207.

Broeze, F. (1989), "Distance Tamed: Steam Navigation to Australia and New Zealand from its Beginnings to the Outbreak of the Great War," *Journal of Transport History,* 10 (1), pp. 1-21.

Doe, H. (2018), *Brunel's Ships and Boats*, Gloucs: Amberley Publishing.

Doe, H. (2019), *SS Great Britain: Brunel's Ship, Her Voyages, Passengers and Crew,* Stroud, Gloucs: Amberley Publishing.

Cohn, R. L. (2005), "The Transition from Sail to Steam in Immigration to the United States," *Journal of Economic History*, 45 (2), pp. 469–95.

Corlett, E. (1990), *The Iron Ship: The History and Significance of Brunel's SS Great Britain* (2nd ed.), London: Conway Maritime Press.

Elston, J. (2011), *Steamship Operation between Britain and Australia: Problems Faced by Steamship Operators,* London: Lambert Academic Publishing.

Farr, G. (1965), *The Steamship Great Britain,* Bristol: Bristol Historical Association.

Fletcher, M. E. (1958), "The Suez Canal and World Shipping, 1869-1914," *Journal of Economic History*, 18(4), pp. 556-573.

Fogg, N. (2002), *The Voyages of the Great Britain: Life at Sea in the World's First Liner*, London: Chatham Publishing.

Fowler, F. (1859), *The Wreck of the "Royal Charter"* London: Sampson Low, Son, and Co.

Fox, S. (2003), *The Ocean Railway,* London: Harper Collins.

Graham, G. S. (1956), "The Ascendancy of the Sailing Ship 1850-85," *Economic History Review*, 9 (1), pp. 74-88.

Harcourt, F. (1995), "P&O and Orient: A Cool Partnership, 1886-1914," *The Great Circle*, 17(2), pp. 73-94.

Harcourt, F. (2006), *Flagships of Imperialism: The P&O Company and the Politics of Empire from its Origins to 1867,* Manchester: Manchester University Press

Harley, C. K. (1971), "The Shift from Sailing Ships to Steamships, 1850-1890: A Study in Technological Change and its Diffusion," in D. N. McCloskey, ed. *Essays on a* Mature Economy: Britain after 1840, Princeton NJ: Princeton University Press.

Harley, C.K. (1988), "Ocean Freight Rates and Productivity, 1740–1913: The Primacy of Mechanical Invention Reaffirmed," *Journal of Economic History*, 48(4), pp. 851–876.

Harley, C. K. (1989), "Coal Exports and British Shipping, 1850-1913*," Explorations in Economic History,* 26, pp. 311-338.

Hatton, T. J. (2024a), "The Political Economy of Assisted Immigration: Australia 1860–1913," *Explorations in Economic History*, 92, Art. 101565.

Hatton, T. J. (2024b), "Sailing Ship Technology, Navigation and the Duration of Voyages to Australia, 1848-85," London: CEPR Discussion Paper 19342.

Hatton, T. J. (2025), "Emigrant Voyages from the UK to North America and Australasia, 1853-1913," *Economic History Review*, 78, (2), pp. 452-473.

Hitchins, F. H. (1931), *The Colonial Land and Emigration Commission*, Philadelphia PA: University of Pennsylvania Press.

Hollett, D. (1986), *Fast Passage to Australia: The History of the Black Ball, Eagle, and White Star Lines of Australian Packets*, London: Fairplay.

Jacks, D., Meissner, C. S. and Wolf, N. (2024), "Suez," London: Centre for Economic Policy Research Discussion Paper 19758.

Jackson, R. V. (1980), "The Decline of the Wool Clippers," *The Great Circle*, 2 (2), pp. 87-98.

Kirkaldy, A. W. (1914), *British Shipping: Its History, Organisation and Importance*, London: Kegan Paul, Trench, Trübner.

Loney, J. and Stone, P. (2000), *The Australia Run: Australian Shipwrecks*, Vol. 6, Benalla, Victoria: Marine History Publications.

Lubbock, B, (1922), *The Blackwall Frigates*, Glasgow: James Brown and Sons.

Maber J. M. (1967), *North Star to Southern Cross*, Prescot, Lancs: T. Stephenson & Sons.

Mival, K. N. (2015), “Re-Assessing the Disappearance of the Clipper “Guiding Star”,” *The Great Circle,* 37 (2), pp. 16-39.

O’Callaghan, J. (1971), *The Saga of the Steam Ship Great Britain*, London: Hart-Davis.

Pascali, L. (2017), “The Wind of Change: Maritime Technology, Trade, and Economic Development,” *American Economic Review*, 107 (9), pp. 2821–2854.

Rabino, J. (1887), “The Statistical Story of the Suez Canal,” *Journal of the Royal Statistical Society*, 50 (3), pp. 495-546.

Rowland. K. T. (1971), *The Great Britain*, Newton Abbott: David and Charles.

Smith, C. (2013), *Coal, Steam and Ships: Engineering Enterprise and Empire on the Nineteenth Century Seas*, Cambridge: Cambridge University Press.

Stammers, M. (2013), *Emigrant Clippers to Australia: The Black Ball Line, Its Operation, People and Ships, 1852-1871*, London: Milepost Research.

U.K. Emigration Commissioners (various dates) *General Report of the Emigration Commissioners*, London: HMSO.

Woolcock, H. R. (1986), *Rights of Passage: Emigration to Australia in the Nineteenth Century*, London: Tavistock Publications.

Appendix 1: Steamship Services to Australia, 1852-1876

The list of steamship ventures to Australia are those summarised by chapter number in Maber (1867), with a few details from other sources, principally: https://www.theshipslist.com/ships/lines/index.htm. The first column includes the name of the company/line and Maber's chapter number. The next two columns are the year that the company/line was established and the years that it sailed to/from Australia. Column (4) is the number of different company-owned ships that were deployed on voyages to Australia (not all of which operated concurrently) with the number of chartered ships in parentheses. Column (5) lists the number of return voyages (where known) and column (6) notes the outward route taken, which often involved calling at intermediate ports. For trans-Pacific services and those via Suez (pre-1869), which involved an overland portion, the numbers of ships and voyages are only for the leg to/from Australia. Column (7) lists whether or not the service was provided under an ongoing mail contract (most ships carried mail on an *ad hoc* basis). All ships carried some goods and cabin passengers and few carried steerage passengers. The final column lists some of the difficulties faced by the company and the circumstances that attended the cessation of the service.

Table A1: Experience of Steamship Company Ventures to Australia initiated in 1852-1875

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Company	**Estab-lished**	**Sailings**	**No. of ships**	**Return Trips**	**Route via**	**Mail**	**Problems experienced and demise**
1a. Peninsular and Oriental Steam Navigation Co. (P&O) (1837)	1837	1852-4	6	>8	From Suez, via Point de Galle, Singapore	Y	Service to Far East from 1843. Link to Australia unprofitable due to high price of coal. Ships commandeered for Crimean war.
1b. P&O	..	1859-60	7	??	From Suez via Aden, Mauritius	Y	High coal consumption led to change of route.
1c. P&O	..	1860-81	25	Many	From Suez, via Point de Galle	Y	Replaced in 1881 by a direct service through the Suez Canal.
2. Australian Royal Mail Steam Navigation Co.	1852	1852-4	5	8	St Vincent, St Helena, Cape own	Y	Unreliable due to frequent breakdowns. Mail contract withdrawn 1853; redeployed as troopships from 1854; company wound up in 1860
3. Liverpool & Australian Navigation Co. (Eagle Line)	1852	1852-76	2	37	Via Cape direct	N	One ship lost the other retired; company (Gibbs Bright and Co.) re-focused its business.
4. T & J Sands & Co.	1852	1852-3	(1)	1	Cape Town	N	Route abandoned; chartered ship redeployed.

5. Vianna, Jones and Chapple	1853	1853	1	1	St Vincent, St Helena, Cape Town	N	Route abandoned due to anticipated competition; ship redeployed.
6. General Screw Shipping Co.	1848	1853-4	7	9	Via Cape direct	N	Mail contract to India. Overextended investments; high coal costs; mechanical difficulties and loss of ship (*Croesus*); company wound up in 1862.
7. Millers and Thompson (Golden Line)	????	1853-4	2	>2	Madiera, Cape Verde, Cape Town	N	Went bankrupt in 1854; ships redeployed.
8. New York & Australian Navigation Co.	1853	1853-4	1	1	Outward via Cape direct	N	Proposed service to Panama abandoned due to high price of fuel; financial loss; ship sold.
9. Australasian Pacific Mail Steam Packet Co.	1852	--	--	0	---	N	Proposed service to Panama abandoned due to high price of fuel; ships chartered by Admiralty; mail contract refused; company wound up in 1854
10. Australian Auxiliary Steam Clipper Co. Ltd.	1856	1856-8	4	5	Cape direct	N	Poor performance of ships; not profitable; company wound up in 1858
11. European & Australian Royal Mail Co.	1856	1857-9	5 (6)	>11	From Suez via Aden, Point de Galle	Y	Frequent mechanical breakdowns and strandings; company insolvent, service taken over by Royal Mail Steam Packet Co. in 1858
12. James Baines & Co. (Black Ball Line)	1852	1863-9	1	4	Cape direct	N	Unprofitable; company in decline, reorganised in 1867; wound up in 1871.
13. White Star Line of Packets	1852	1863-6	1	3	Cape direct	N	Unprofitable; poor performance of ship; company in decline; line sold in 1867 to T. H. Ismay
14. Money Wigram & Co.	1837	1864-93	10 (>4)	Many	Cape; return via Suez post-1869	N	Increasingly unprofitable—competition from Orient Line; company shifted towards cargo
15. Robertson & Co.	1865	1865	1	1	Cape?	N	Shifted to China trade
16. Panama, New Zealand & Australia Royal Mail Co.	1863	1866-8	5	??	From Panama via Wellington, Rapa	Y	Unprofitable; company collapsed in 1868
17. Devitt and Moore	1863	1871	3	<5	Cape	N	First steamer wrecked in 1871; continued with sailing ships only.

18. Australian Steam Navigation Co. (American-Australian Line)	1851	1870-1	2	>10	From Honolulu (link from San Francisco), via Auckland,	Y	Linked with North Pacific Transportation Co; mail contract not renewed; company wound up 1871
19. California, New Zealand and Australia Mail Steamship Co.	1871	1871-3	5	>15	Honolulu (link from San Francisco), via Auckland	Y	Poor performance of wooden paddle steamers; mail contract for through service not continued; company collapsed in 1873
20. Eastern & Australian Mail Steamship Co. Ltd linked with P & O	1873	1873-81	9 (5)	Many	From Singapore Link from Suez), via Batavia	Y	3 ships lost; mail contract discontinued; ships sold/redeployed.
21. Australasian & American Mail Steamship Co.	1873	1874-5	(6)	>15	From San Francisco, via Honolulu	Y	Unprofitable; financial collapse 1875.
22. Colonial Line	1873	1873-87	(21)	Many	Cape Town and Suez	Y	Charter voyages only, sometimes cargo only; change of management, business redirected.
23. Australia Direct Steam Navigation Co.	1874	--	1	0	Suez	Y	Proposed service abandoned (no contract?).
24. Pacific Mail Steamship Co.	1848	1875-85	5 (4)	Many	From San Francisco via Honolulu, Fiji	Y	Mail contract renewal not sought in 1885; ships sold.

Appendix 2: Gibbs Bright and Co. and the Liverpool and Australian Navigation Co.

Much of what follows is based on the account provided by Elston (2011) who drew on the Gibbs, Bright and Co. archive at the University of Melbourne, among other sources. This is supplemented with additional material drawn directly from the archive.

The company emerged in 1818 from a close business relationship between George Gibbs Robert Bright, and with Samuel Bright, the partnership became Gibbs, Bright and Co. in 1824. The Gibbs and Bright families were long established merchants in the 18th century West Indian trade based in Bristol and Liverpool, but this dwindled with the abolition of the slave trade. Robert Bright became a director of Brunel's Great Western Railway Company and when a transatlantic steamship service was proposed, Gibbs, Bright and Co. took shares in the Great Western Steamship company, which was created in 1836 with both George Gibbs and Robert Bright on the board of directors. Having built the *PS Great Western*, which successfully plied the Atlantic to New York, the company planned to expand its fleet to provide a regular service and to bid for a government mail contract.

As noted in the main text, Brunel's plans for the company's next ship became ever more ambitious. In particular, the original plan to build a paddle steamer was changed to a screw steamer and the engines originally commissioned from a separate builder were instead built in house. The *SS Great Britain* was eventually launched in 1843 and made four voyages from Liverpool to New York before the disaster at Dundrum Bay in 1846. Although this heralded the end of the Great Western Steamship Co., Gibbs Bright and Co. had by 1851 built a fleet of twelve sailing ships trading in the Baltic, the Americas and the Far East, and in the process developed a worldwide network of agents. With the discovery of gold, they turned to Australia, reforming the partnership, establishing the Eagle Line and acquiring several clippers for fast transport of goods and passengers.

In 1850 Gibbs Bright and Co. bought the *SS Great Britain* for just £18,000 to be refitted and join the fleet of clippers in the Australian trade. The cost of the refit is not clear but at the 1849 General Meeting of the Great Western Steamship Co. a quote of £15,000 was provided by R. M. Patterson for conversion to a sailing ship. O'Callaghan (1971, p. 103) notes an 1850 estimate of £15,886 for refitting the hull and rigging and £5,808 for engines. However, he goes on to note that "the bill was almost certainly greater because Gibbs, Bright and Co. brought up William Patterson and the firm decided to fit new engines made by John Penn of Greenwich." Thus it seems likely that the total cost, including purchase would have been on the order of £50,000, perhaps even as much as £60,000. As noted above, this is still less than half of the original construction cost although the ship was valued at much more (Table A2).

The *Great Britain's* first voyage to Australia was in 1852, and initially Gibbs Bright and Co. used local agents, but in 1853 Charles Edward Bright joined his brother Reginald Bright in forming the partnership Bright Brothers and Co., based in Melbourne. Their objective was to gradually expand their agency by building a reputation for integrity, reliability and attention to detail. Bright Brothers and Co. later became agents for the Black Ball Line and the Orient Line and established their own shipping business, opening offices in other Australian cities, as well as

diversifying into a range of other businesses until absorbed back into Gibbs, Bright and Co in 1881.

In 1854 Gibbs Bright and Co. established a new subsidiary specifically for steam, the Liverpool and Australian Navigation Co., to which the *Great Britain* was transferred for £112,000. The aim was to build a fleet of steamships to operate in conjunction with the sailing packets of the Eagle Line. It was launched with capital of £400,000 with the intention of establishing a regular service and in the hope of receiving a mail contract. But in the meantime the *Great Britain* was redeployed as a troopship for the Crimean War making eight voyages in 1855-6 and earning perhaps as much as £130,000.[37]

In 1855 the company bought from a bankrupt builder an incomplete iron clipper ship, the *Royal Charter,* which was converted to steam but with modest engine power of 200 horsepower. In a new prospectus to increase its capital, the Liverpool and Australian Navigation Co. stated that its objective was to combine sail and steam "not in the way it has been hitherto attempted by an auxiliary screw applied to a hull rigged neither as a steamer nor a sailing ship, but by the application of a small steam-engine to a large full-rigged Clipper-Built sailing ship of the most approved model." And it noted "the readiness of governments . . . to give an annual subsidy for the mails to any responsible company who will undertake the service."

After the *Great Britain's* service as a troopship, the company entered into negotiations to sell it to a French company. When this fell through it was decided that the ship could only be returned to the Australian trade "if such alterations were made as to render her a most perfect Clipper Sailing Vessel, and altogether independent of her steam power" (Proceedings of the 3rd Annual Meeting of the Shareholders, 1857). Consequently, a major refit was undertaken, which as noted in Appendix 3 below, increased its carrying capacity and its qualities as a sailing ship. After service as a troopship to Bombay and one voyage to New York the *Great Britain* returned to the Australian run.

The company then faced three major setbacks. The first was the failure to be awarded a mail contract. The chosen route was from Southampton to Suez, overland, and then to Point de Galle (Ceylon) with a link to Australia, and so in 1856, a contract was awarded to the P&O company. The second was increased competition as the supply of shipping outran demand. And the third was the complete loss of the *Royal Charter* on its return voyage in 1859 when a hurricane drove it on to the rocks of northeast Anglesea with the loss of 454 lives. This hit the company hard both in reputation and cost but did not bankrupt it as the insurance yielded £77,856 2s 11d. While the idea of expanding capacity to provide a monthly schedule lingered on, from that time onwards the company ran the *Great Britain* only, gradually reducing its capital as the ship was depreciated.[38]

[37] Elston (2011, p. 210) notes that in this service the *Great Britain* earned £2 10s per gross ton per month, which would amount to about £130,000.

[38] In 1864 the company acquired the *Lady Darling*, a 650 ton iron cargo steamer, but this was shortly sold to Bright Brothers and Co., and used mainly for coastal trade until returning to Liverpool in 1867.

As Table A2 shows, the years 1859-1860 were loss-making years, marked by intense competition. In 1858 Gibbs, Bright and Co.'s Eagle Line amalgamated its schedule with that of the Black Ball line (Baines and Co.), also in conjunction with the *Great Britain* and the *Royal Charter*. From 1861 the *Great Britain* alone earned around 20 percent on costs. Gross earnings vary from year to year as some years include two voyages and some years just one. As the table also shows, after the loss of the *Royal Charter*, the book value of the *Great Britain* was gradually reduced. As reflected in Table A2 the company's fortunes revived in the 1860s, partly due to the American Civil War, and earnings amounted to around 20 percent over costs.

Table A2: Revenues and Expenditures of the Liverpool and Australian Navigation Co.

Year	Gross earnings (£)	Expenditure (£)	Profit (£)	Profit rate (£)	Ships cost (£) (depreciated)
1855	63,841.5	51,438.8	12,402.7	24.1	
1856	62,982.3	34,659.3	28,323.0	81.7	
1857	98,260.8	74,934.8	23,317.0	31.1	
1858					210,144.0
1859	47,451.8	48,423.1	-971.3	-2.0	170,608.9
1860	69,025.2	71,284.4	-2,259.2	-3.2	93,782.4
1861	32,309.7	28,265.4	4,044.4	14.3	95,741.8
1862	65,398.2	51,211.8	14,186.4	27.7	86,516.7
1863	30,428.6	25,316.2	5,112.4	20.2	81,785.0
1864	68,729.1	55,776.1	12,953.0	23.2	83,821.4
1865	62,262.6	49,396.2	12,866.4	26.0	70,915.0
1866					72,696.3
1867	60,214.0	50,965.2	9,248.8	18.1	63,447.5
1868	26,749.1	22,083.4	4,665.7	21.1	51,877.5
1869					46,012.0
1870	52,173.4	46,160.2	6,013.2	13.0	39,998.8
1871	48,336.6	43,227.0	5,109.6	11.8	34,889.2
1872	16,913.2	22,479.7	-5,566.5	-24.8	

Source: Elston (2011, p. 263). *Notes*: The last column appears to represent the book value of ships rather than the original cost for purchase and refit by Gibbs, Bright and Co. In 1858 and 1859 this includes both the *Great Britain* and the *Royal Charter*.

In 1864 two abortive attempts were made to form a new steamship company which would include the *Great Britain* with steamships originally acquired by the Black Ball and White Star lines. In 1867 the joint service with the Black Ball Line ceased as the latter faced financial difficulties. As shown in Table A3, from 1866 the *Great Britain* carried some assisted passengers, either selected by agents in the UK or under warrants issued in Australia for those nominated by colonists. While a useful supplement, these accounted for only around 15 percent of all passengers. By the 1870s the *Great Britain* was ageing and competition from newer ships was increasing, and its last voyage to Australia was under charter to the Colonial Line. On its return in 1876 it was laid up at Birkenhead. This effectively marked the end of the Liverpool and Australian Navigation Co. but not of Gibbs, Bright and Co., which continued to trade under that name until 1983.

Table A3: Assisted migrants Travelling on the *SS Great Britain*

Voyage	Assisted Passage	Passengers
April 1866	Unspecified number of warrant passengers	
December 1866	Unspecified number of warrant passengers	
July 1867	CLEC chartered passengers (for Victoria and S. Australia)	224
September 1868	Unspecified number of assisted passengers	6+
April 1869	Warrant passengers	121
October 1869	CLEC chartered passengers	143
May 1870	Warrant passengers	208
December 1870	Warrant passengers	188
July 1871	Assisted immigrant or warrant passengers	60
February 1872	Unspecified	98
September 1872	Unspecified	18
May 1873	Warrant passengers	81
December 1873	Warrant passengers (for Queensland)	214
July 1874	Warrant passengers	40
March 1875	Unspecified number of warrant passengers	

Source: Brunel Institute Research Centre, document VSI/02/2019. *Notes*: The passengers are assumed to be for Victoria unless otherwise stated. Passage warrants entitled the shipping company to collect a fee (typically £14) from the Victorian Treasury for each emigrant introduced by a friend or relative in Australia who had nominated them and put down a deposit. CLEC (Colonial Land and Emigration Commissioners) passengers were those selected by agents in the UK (so-called assisted emigrants) and these normally travelled on ships wholly chartered by CLEC.

Appendix 3: *SS Great Britain*: Timeline of Technical Evolution, 1843-1876

The details that follow are mainly from what is by far the most authoritative account of the ship, that of Corlett (1990), particularly his appendices 3-7; page references (C**). The focus here is on voyages and refits.

1843: official launch, floating harbour, Bristol, 19 July 1843. 3,442 tons, with iron hull, length 322 ft., beam 50.5 ft., draught 16 ft., shaped along clipper lines i.e. "fine hollow entrance and fine run aft" (C40) but not amidships where it was more bulbous. Four decks: lower cargo, lower and upper tween decks and weather deck; accommodations for 360 passengers, 1,200 tons of cargo (22,000 cu ft.), coal bunker capacity 1,100 tons. Six masts: mainmast (no. 2) square rigged, the other 5 masts lateen rigged (originally with wire) and hinged at deck level; total sail area approx. 16,000 sq. ft. (exc. studding sails on mainmast, "rarely used" (C74)). Single funnel. Engines: 3-bay boiler, pressure about 5 psi; four inclined 88 in cylinders; 1000 nominal hp, approx 1485 iph; 11 knots at 16 rpm. Chain driven six blade screw propeller, fixed and forward of rudder; gear ratio 2.95. Total cost: £117,295 6s 7d plus £53,081 12s. 9d. for the building establishment and £1,330 4s. 9d for alteration to the locks (Farr, 1965, p. 6).

1845-6. Trials included voyages to London and Liverpool. First two voyages from Liverpool to New York return; outward 14 days 21 hours and 15 days 12 hours; return 18 and 20 days respectively. Second voyage: lost mainmast and spanker and lost blades of screw. Refit: replacement with four-bladed screw; boiler pumps and flues altered; mast no 3 removed, two square rigged (the original 2 and 4), and hinges removed. Two further voyages, Liverpool – New York. On the first outward voyage engines shut down due to fractured air pump, took 20 days. On next outward voyage to New York, on 22/9/1846, 9.30pm, ran ashore at Dundrum Bay, Northern Ireland.

1847-52. After 11 months re-floated on 27/8/1847 and returned to Liverpool's Coburg Dock. As insured only for only £17,000, this forced the sale of the *Great Western*. Sold in December 1850 to Gibbs, Bright and Co. for £18,000. 1851-2 Refit: Hull reinforced; cargo capacity increased by 1,000 tons; 300ft deckhouse added: passenger space increased to 730 (50 1st class); coal bunker capacity 1,200 tons; draught increased to 22 ft. One mast removed (the original no. 5; original 2 and 4 square rigged); sail area increased to 27,000 sq. ft.; twin funnels. New engines fitted: two 3-bay boilers, about 10psi; two oscillating 82.5 in cylinders; 500 nominal hp, approx. 1420 ihp "not dissimilar to that of the original machinery" (C122); 11 knots at 24 rpm. Transmission by gearwheels to 3-blade (fixed) screw propeller, gear ratio 3.

1852-4. One voyage to New York; first voyage Liverpool to Melbourne, 83 days out, 88 days return via the Cape of Good Hope. Ran short of coal on outward voyage "as the route chosen was that of a steamship" (C134); turned back to St Helena for coal. Called at Cape Town outward and St Helena and Vigo on return. 1853 refit: 3 masts, all square rigged in changed positions, all carrying topmasts, topgallants and royals. Two-blade screw fitted. Two further voyages: Liverpool—Melbourne: 65 and 72 days outward; 66 and 63 days return. On the second outward, stern tube liner (transmission to the screw) seized—6-week delay; return via Cape Horn. Ownership transferred in 1854 from Gibbs, Bright and Co to their subsidiary, the Liverpool and Australian Steam Navigation Co.

1855-56. Commissioned as a troop ship for the Crimean War; voyages to Malta and Constantinople. 1857 refit: deckhouse widened and extended to stern. New heavier masts fitted, positions altered, new double topsails, topgallants and royals; larger bowsprit and jib boom and longer yards; total sail

area about 33,000 sq. ft.; single funnel fitted. New two-blade retractable screw on a lifting frame. One voyage to New York and one to Melbourne—62 days outward 94 days return. Followed by one voyage carrying troops to Bombay in response to the Indian Mutiny and a voyage to New York.

From 1858 to 1875 made 28 voyages to Australia (including carrying the English cricket team for its first tour of Australia in 1861 and again in 1863). On an 1860 voyage collided with another ship near Cape Otway and on the return stranded on a sandbank in Liverpool bay but with no damage. In a refit of 1863 the boilers were replaced and the spar deck extended. On a return voyage in 1872 the ship lost its topgallant mast in a storm off Cape Horn. Decking replaced in 1872 and submitted to Lloyds for classification, which was declined owing to its “peculiar construction” (C147). On the next voyage captain Gray mysteriously disappeared overboard during the return. On its last voyage as a steamer in 1875-6 the ship made 76 days out and 66 days return.

Appendix 4: Tracks of the *SS Great Britain* in 1861 and 1864-5

The tracks of two voyages of the *Great Britain* from Liverpool to Melbourne (in grey) are compared with the tracks of 290 sailing ships from European ports to Melbourne (in black) in 1854-62. The latter are discussed in Hatton (2024b). The underlying data was collected from ships' logs and reported by Neumayer (1864). For the passage south through the Atlantic these are recorded as readings of longitude for benchmarks of latitude and for the passage east through the southern oceans, they are latitudes for benchmarks of longitude. The dots represent the mean and the whiskers are one standard deviation either side of the mean. Data for the outward voyage of the *Great Britain*, October to December 1861, were taken from the ship's newspaper, *The Cabinet* (1862). Data for the outward voyage in December 1864 to February 1865 are from a diary of an unknown passenger. Both of these are daily records of latitude and longitude. For the comparison, these were interpolated between days to obtain benchmarks similar to those recorded for the 290 sailing ships.

The results in Figures A1 and A2 below indicate that the *Great Britain* followed a track similar to those of the sailing ships, emphasising its dependence on sail. On the southward passage the Great Britain's tracks are close to the average for sail. In particular, from the equator to about 30°S it sailed southwest rather than following the "steamship route" which would have been more southeast from the equator. Indeed, in 1861 it sailed further west between 30°S and 40°S than the average for sailing ships. On the run to the east the *Great Britain* followed a track south of the average sailing ship, similar to that of the clippers (Hatton 2024b).

References

Anon (1865), Manuscript Diary of Voyage Liverpool to Melbourne 1864-5, Held in the Vaughan Evans Library at the National Maritime Museum, Sydney.

Hatton, T. J. (2024b), "Sailing Ship Technology, Navigation and the Duration of Voyages to Australia, 1848-85," CEPR Discussion Paper 19342.

Neumayer, G. (1864), *Results of the Meteorological Observations taken in the Colony of Victoria, during the years 1859-1862 and of Nautical Observations Collected and Discussed at the Flagstaff Observatory Melbourne, during the years 1858-1862*, Melbourne: Govt. Printer.

Reid, A. (1862), *The Cabinet, Facts, Figures and Fancies relating to the Voyage of the Great Britain from Liverpool to Melbourne,* Melbourne: Mason and

Figure A1: Track of the SS Great Britain in 1861 (grey) and tracks of 290 sailing ships from Europe to Melbourne 1854-62 (black)

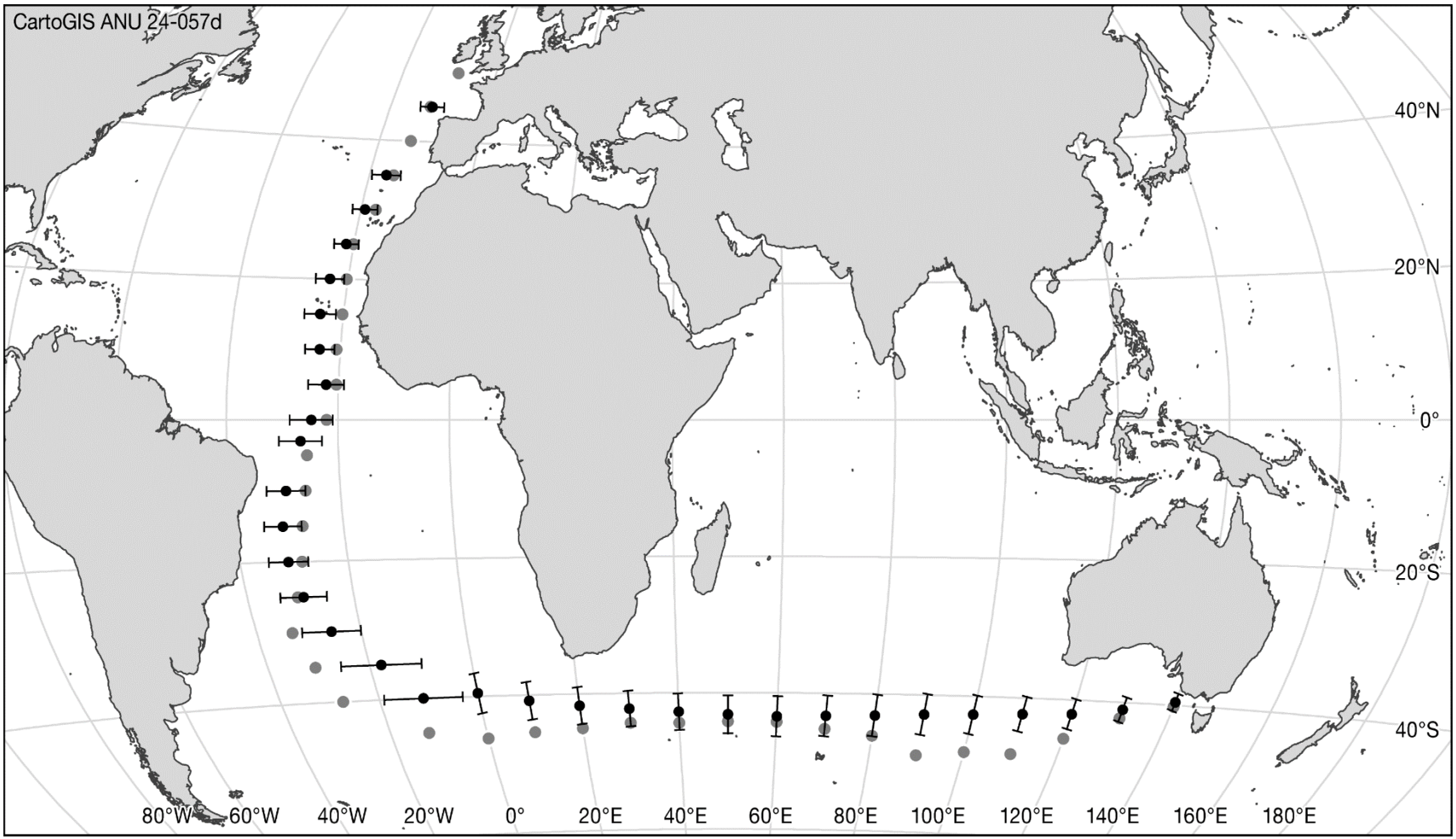


Figure A2: Track of the SS Great Britain in 1864-5 (grey) and tracks of 290 sailing ships from Europe to Melbourne 1854-62 (black)