Research Policy 42 (2013) 1724–1738

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

The "sailing ship effect": Reassessing history as a source of insight on technical change

Sandro Mendonça [a,b,*]

[a] Department of Economics, ISCTE Business School, BRU and Dinâmia-CET, Lisbon University Institute – ISCTE, UECE, ISEG-UTL, Portugal
[b] SPRU, University of Sussex, United Kingdom

ARTICLE INFO

Article history:
Received 14 March 2011
Accepted 17 December 2012
Available online 29 October 2013

Keywords:
"Sailing ship effect"
Innovation
Diffusion
Old technology
Economic history

ABSTRACT

The so-called "sailing ship effect" has often been stated as though there is no doubt that it really took place in the end of the 19th century. The notion has, moreover, been used as a stylised fact that is in charge of conveying the idea that the substitution threat of new radical technologies may lead to a renewed spurt of innovation in an old and established technology. On the basis of quantitative evidence and a systematic review of the field of maritime history this paper shows that the effect is nowhere to be found in the very case it derives its name from. The modernisation of the sailing trader occurs before, not after, the steamship had become an effective competitor. It is argued that if history is to be used to give credence to explanations of empirical regularities in a variety of settings the original source of the relevant concepts must be carefully revisited and deeply researched.

Every faraway steamer is a nearby sailing ship.

Every distant ship seen now is a ship from the past seen up close.

(Álvaro de Campos, *Maritime Ode*)[1]

1. Introduction

A full hundred years after the launch of the *Clermont* of 1807 and the *Comet* of 1812, the first for-profit steamboats deployed in the United States and Great Britain respectively, a large fleet of fully rigged cargo-carrying sailing ships was still afloat and fully active in the world's oceans. One case was the *Preussian*, depicted in Fig. 1. She was the only five-mast tall ship ever built (Baker, 1965, p. 206; Dudszus and Henriot, 1986, p. 182). Built of steel between 1902 and 1904 this German barque was square-rigged on all masts. She measured 5081 tonnes gross, had 5560 m^2 of sail area, and could run up to speeds of 18 knots with a relatively small crew. In 1907, exactly one hundred years after the economic introduction of the steamer, she could be found on a round-the-world voyage, one of the very last performed by a wind-powered cargo square-rigger (Lloyd's *List*, 1984, p. 191). In 1910 a cross-Channel steamer named *Brighton*, said to have underestimated her speed, collided with her in somewhat hazy conditions and the sailing giant subsequently became a wreck (Hendry, 1938, p. 24; Kemp, 1978, p. 207). The loss of the *Preussian* was a regarded as major event at the time (Scott, 2011, p. 97).

Deep water commercial sail was still a common-place reality back then. Large numbers of windjammers, barques and schooner-rigged vessels, bulkier but more efficient than the celebrated and graceful clippers that preceded them, sailing for American, Finnish, French, German, and Portuguese interests, were actively engaged in many routes until the Great War (see, e.g., Kirkaldy, 1914, p. 38). By the mid-1920s there still more than one hundred sail cargo traders roaming the world, and they reportedly could nearly match steamers' regularity and speed in breezy routes (Gilfillan, 1935, pp. 162–3). A dwindling fleet of ocean-going traders remained in business until the Second World War, a few of them, like the *Lawhill* and the *Pamir*, even beyond (see Anderson et al., 1996, and Parrot, 2002).

"The period of transition from sail to steam propulsion at sea was a long one." (Brock and Greenhill, 1973, p. 9) The modernisation of merchant shipping can thus be seen as a textbook example of Freeman and Louçã's (2001, p. 145) observation that "the emergence, crystallisation, and diffusion of new technology systems is a matter of decades, not just years." Indeed, many decades. It was only well into the second half of the 19th century that steam propulsion became economically challenging and, eventually, a preferable alternative to sail in virtually every maritime trade (Harley, 1972; Pollard and Robertson, 1979; Starkey and Jamieson, 1998). The striking difficulty of a new industrial technology in defeating the product of such an ancient sector led economists and students

* Permanent address: Department of Economics, ISCTE Business School, Av. das Forças Armadas, 1649–026 Lisbon, Portugal.
E-mail address: sfm@iscte.pt

[1] Translation by Richard Zenith (ed.) (2006), *Fernando Pessoa. A Little Larger Than the Entire Universe. Selected Poems*, London: Penguin, p. 172.

0048-7333/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.respol.2012.12.009

Fig. 1. The *Preussen*, built in Germany during 1902–1904, the only five-masted cargo square-rigger ever built.
Source: Lloyd's List (1984, p. 191).

of technical change to refer to the existence of a "sailing ship effect". The general point behind the term is the possibility of competitive innovations by an older, and by implication, supposedly slow-moving or sclerotic technology.

In the innovation studies community the "stylised fact" of a significant and surprising latter day revival of an ageing technology, stimulated into action when threatened, appears to have gained currency through Nathan Rosenberg (1972, 1976). According to the available scholarship (Freeman and Soete, 1997, p. 105; Grübler, 1998, p. 204; Mom, 2004, p. 308), the construct seems to have first been labelled by a New Zealand scientist in a short article (Ward, 1967) and is now staple in leading innovation studies textbooks (e.g. Tidd et al., 2005, p. 24). At a first approximation the persistence of sail in a world dominated by steam shows how "development continues even on obsolescent lines." (Aghion and Howitt, 1997, p. 314) The phenomenon is therefore a specific mechanism, among others expected by economy theory such as learning-by-doing and learning-by-using, that contributes to retard the phasing out of mature technologies (de Liso and Filatrella, 2009, p. 119). Emphasising the comparative dimension of the concept Freeman and Soete (1997, p. 355) describe the "sailing ship effect" as a series of improvements in the older technology which augment its capabilities and prolong its economic life. That is, new technologies face a moving target. Hence, as Grübler (1998, p. 204) points out, the late surge in productivity in the incumbent technology slows down the take-up rate of the entrant technology; thus, for instance, the long process of steamship dissemination may be read as being explained by "major technical improvements in clippers when challenged by competition from steam ships." That is, innovation accelerates in the old technology due to the struggle against the challenging substitute technology, of which it may even incorporate some of individual features (Utterback, 1994, p. xxxix, p. 87).

This paper is an effort to reassess what actually was going on in the relationship between the sail and steam 19th century transportation systems. The notion of "sailing ship effect" is taken to mean an acceleration of performance in the key characteristics of an established product caused by technical change happening as a response to a competitive pressure exerted by a rival product entering the same market but based on a new, often radically new, technology. Our agenda leads us to questions such as: Were sailing ships and steamships effectively producing identical services? What improvements were taking place in ship design and materials? What was the precise historical timing of technological developments? We try to answer these questions by drawing extensively on specialised maritime historiography and by exploiting under-utilised sources of quantitative and qualitative evidence on ship performance and characteristics. In combining data analysis with an evolutionary or neo-Schumpeterian perspective our efforts could be said to follow an "appreciative theorising" (Nelson and Winter, 1982, p. 9) or "reasoned history" (Freeman and Louçã, 2001, p. 117) approach to the study of technical change.

We conclude that the insight conveyed by the "sailing ship effect" hardly seems justified by the history of the sailing ship. In line with Howells (2002) and Edgerton (2008), who have produced powerful critiques of the widespread interpretation of the sailing ship story, we find that the innovation studies literature often fails to provide sources or even maritime history context to the phenomenon. Gilfillan (1935), who is often cited in association to the "sailing ship effect", cannot be understood as one of its proponents. Moreover, our own exploration of the historical data returns findings at variance with the concept. We find evidence of marked improvements in sailing ships that were underway well before steamers emerged as viable cargo carriers on longer voyages. What is more, the concept of "sailing ship effect" could even be turned on its head as steam navigation emerges as a prime receiver of innovations originally developed within the context of intra-sailing ship competition.

In the light of maritime economic history the so-called the "sailing ship effect" appears to be a concept lacking substantive underpinnings. The pattern has nevertheless guided research that cuts across sectors and historical periods. As an instrument used to open up new explanatory avenues it may have, undoubtedly, yielded interesting insights. Our questions here focus more the actual past facts behind the "stylised fact" rather than on the conjecture taken in isolation and whether or not it still retains power to illuminate other instances of innovation. Old technologies may go through periods of renaissance and re-invention. And the ending phase of technology's life-cycle may, indeed, be as rich in insight as its origin and growth (Coppersmith, 2010). The threat of radical replacement could well have positive externalities on the existent technologies and act as accelerator of change, but that is an empirical question to be determined case by case. However, the mere plausibility and a pale, or even distorted, resemblance to the contours of historical events does not qualify the "sailing ship effect" as an unproblematic instrument of long-term perspective into the phenomenon of innovation. The transformation of a historically rooted observation into a concept remains a delicate manoeuvre and surely abstractions must be judged first and foremost by their fit to the case from which they are extrapolated. History constitutes a uniquely productive area for "basic research" in the social and economic sciences, i.e. a source of new conjectures as well as of empirical data for hypothesis testing. Nevertheless, the role of historical analysis as a tool for theoretical variation and selection in fields such as innovation studies is best approached in the same careful and sceptical way as any other methodology. It may well be that one risks learning imprecise history lessons and that this may bias the search for new facts and the retention of policy ideas. Fortunately the past is rich enough to enable a continuous work of improvement over what constitutes useful knowledge for the future.

The paper is organised as follows. Section 2 locates the "sailing ship effect" in the economics and technology history literatures. Section 3 provides a quantitative assessment of the timing and magnitude of the "sailing ship effect". The next two sections discuss the dynamics of British sailing ship evolution in the long 19th century. Section 4 addresses the changing institutional framework, namely the trading and tonnage laws, in which some of the pioneering sailing ship innovation took place and links this process to an evolving pattern of intra-industry competition that lasted until the late 1860s. Section 5 explores the connection with steamers, impact of the opening of the Suez Canal and follows the path taken sailing ships until the First World War. Section 6 concludes.