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Assessing the role of steam power in the first industrial revolution: The early work of Nick von Tunzelmann

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ABSTRACT

This article considers the historiographical and theoretical significance of Nicholas von Tunzelmann's first book, *Steam Power and British Industrialization to 1860*. Von Tunzelmann assessed the quantitative impact of the Watt steam engine and its pirate copies on the British economy using the social savings method pioneered by R.W. Fogel, showing that the impact was smaller and later than many historians had supposed. These results are of more than quantitative significance because they call into question a dominant line in the history of industrialization that focuses on the steam engine as a key determinant of the dynamics of industrial growth in Britain from the late eighteenth century. This article discusses the origin of this line in the work of Arnold Toynbee and outlines its long-term influence on economic history, including contemporary debates on the question of why Europe outpaced China and India from the seventeenth century. These issues are important also for innovation studies, which often describes the relation between innovation and growth in terms of such 'critical technologies' as steam power; these accounts are subject to the same weaknesses as technicist histories of industrialization. Von Tunzelmann's early work is therefore of continuing theoretical and empirical significance as we seek an adequate theory of the links between innovation and growth.

1. Introduction

There are many reasons to honour Nick von Tunzelmann, but one of them is the path-breaking character of his early work. This paper discusses some of the conceptual and historiographical implications of his first major book, *Steam Power and British Industrialization to 1860*, published in 1978. Our view at the time was that his work contributed not only to the history of steam power directly, but was also fundamentally important for understanding the nature of the first industrial revolution and the character of long-term economic dynamics more generally (Bruland and Smith, 1981). Here we reconsider the book thirty years on, drawing on our previous assessment and looking at what has happened since.

2. The issues: steam power and the dynamics of growth

The specific issue raised by von Tunzelmann's work is the quantitative impact of steam power on British national income, from the early industrialization of the late 18th century to the consolidated industrial economy of 1860. But it raises a much wider question to do with how radical innovations relate to economic change. The importance of *Steam Power and British Industrialization to 1860* is that in investigating the relations between the diffusion of James Watt's engine and the growth of the British economy as a whole, as well the specific effects on some related sectors, it provides "the first detailed critique of the 'energy crisis' interpretation that is implicit or explicit in many of the best-known histories of the industrial Revolution" (von Tunzelmann, 1978, p. 8). But this exploration leads on to major issues about the causal links between innovation, industrialization and growth.

Researchers in innovation studies and innovation economics tend to be familiar with the alleged roles of steam power, mechanized textile technologies and other radical innovations via theories of growth based on long waves of techno-economic development. This line of thinking was initiated by Kondratiev, elaborated by Schumpeter, and formalized most recently by Chris Freeman, Francisco Louça and Carlotta Perez (Freeman and Louça, 2002; Perez, 2002). These authors write the history of large-scale economic change around "critical technologies" that have large-scale generic effects, creating "techno-economic paradigms" that initiate and focus patterns of investment, chains of innovation and financial commitments. The breakdown of the paradigm is argued to be linked to financial crisis, and so this literature relates structural crises in capitalism to the trajectories of radical technologies. A related influential literature is the growth theory based on "General

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Purpose Technologies" (GPTs) (beginning with Helpmann, 1998). Within the GPT literature, the approach sees the technology as the primary determinant of change, but tends to take a more cautious view on timing, recognizing that the critical technologies may take a long time to develop (see for example the major attempt to build a growth theory on GPTs in Lipsey et al., 2005). The detailed history of steam power is important in these theories because the validity of the theories is closely dependent on whether or not the critical technologies do in fact have the impacts that are claimed for them, and dependent on whether the technologies play the causal role in growth and change that is assigned to them. Within the wave tradition, authors usually see steam as an emblematic device of the industrial era and the first Kondratiev wave, unleashing both structural change and an investment cycle. Some authors in essence accept the wave approach but add to it by seeking an explanation of how the relevant critical technologies emerged, with state sponsorship being a favoured factor (for example, Moe, 2007).

It should be noted that the critical technology approaches to growth were not original to Schumpeter, and arguably the GPT approaches are not particularly new either. Rather, steam power and its allegedly revolutionary growth and transformation effects have been central to economic histories of the industrial revolution for a long time, in a tradition that derives from the writings of Arnold Toynbee in the late nineteenth century. In this tradition, steam power was, in T.S. Ashton's formulation, "the pivot on which industry swung into the modern age" (Ashton, 1968, p. 19). Toynbee had a powerful influence on the economic history of industrialization. So von Tunzelmann's work is relevant not only to the modern innovation-based growth theory that succeeded his work, but to long term themes in British economic history that preceded it. However the economic history of industrialization has continued to develop, and indeed has extended into major debates on the evolution of the global economy that offer new perspectives on innovation and growth.

The remainder of this paper is in three parts. In the first we outline the particular way in which steam power was integrated into early histories of industrialization by Toynbee, and how it became central to the historiography of the "Industrial Revolution". In the second part we overview von Tunzelmann's work on steam power, and discuss its implications not only for measuring but also for conceptualizing industrialization. Finally, we discuss economic history since *Steam Power and British Industrialization*. Steam and coal remain central in some recent works of global economic history – especially the works of Kenneth Pomeranz and Robert C. Allen – that seek to explain why Britain and then the rest of Europe industrialized while India and China lagged. The global changes initiated by industrialization are now an area of considerable debate among historians (see O'Brien, 2010 for a comprehensive discussion), and so von Tunzelmann's work resonates outwards into large-scale contemporary issues and debates.

3. Conceptual origins of the "industrial revolution"

The term "industrial revolution", around which historical discourses on late eighteenth- and early nineteenth century Britain tend to be constituted, is a familiar one. It has provided the basic object of investigation, and the general context of specific arenas of research, for a large historiographical enterprise from which an important element is missing, namely an exploration of the theoretical background of the term "industrial revolution" itself. Too often, the term is treated as though its content is transparently plain. But the category does have, of course, a theoretical history of its own, and its mode of constitution has had significant effects, the most important of which has been to establish what might be called a "critical technology bias" at the core of British economic history. This bias consists in according analytical pride of place in economic history to the innovation of disruptive products and processes, and their impacts on output and fixed capital investment, in a small group of leading sectors. The wider multi-sectoral spread of innovation, and the less tangible organizational and structural changes of the period, are subordinated to technological change in the critical sectors, or sometimes even seen as the effect of such change.

The systematic use of the term industrial revolution was inaugurated in a series of lectures delivered in Oxford by Arnold Toynbee in the early 1880s. He never organized the material of these lectures for publication, but after his death his notes, plus lecture transcripts by some of his students, plus various finished and unfinished essays and occasional writings were collated by W. J. Ashley and Bolton King, under the general supervision of Toynbee's wife, and published as *Lectures on the Industrial Revolution of the Eighteenth Century* (*Popular Addresses, Notes and Other Fragments*) (Toynbee, 1884).

The text is by no means a recognizable economic history of the modern type, and is in fact very wide in scope; this breadth of scope means that it has had multiple legacies. It contains an extended account of the structure of the English economy and English society in 1760 (six chapters), followed by a discussion of the demographic, agrarian and industrial changes of the next eighty years (compressed into one chapter), with one further chapter on the condition and prospects of the working class, and the effects of trades unions and factory legislation. The industrial revolution, at least in Toynbee's initial view, covers a wider range of phenomena than industrialization: it incorporates population growth and other demographic changes; an agrarian revolution comprising the destruction of the common field system, enclosure, and the consolidation of small farms into large; the substitution of the factory system for domestic manufacture; and the expansion of the trade and distribution system. A very substantial portion of the text consists of a discussion of economic theory: there are chapters on mercantilism and commercial policy, on the development of economic theory, on Malthus on diminishing returns and population theory, on Malthus's wage-fund theory, on Ricardian rent and profit theory, on the criticisms of Ricardo by J. S. Mill and Nassau Senior, on the relationship between Classical Political Economy and capitalism, and so on. This way of thinking about coterminous change across multiple social arenas, combined with analysis of intellectual concomitants of change, can be found in major subsequent work, such as Polanyi's *The Great Transformation* (Polanyi, 2001). But the Toynbeean legacy relevant here is his specific concept of industrial revolution.

Toynbee's conceptualisation of the industrial revolution has two elements. On the one hand there is the process of competition that emerged from the social transformations indicated above. The perspective here is that

> The essence of the Industrial Revolution is the substitution of competition for the medieval regulations which had previously controlled production and distribution of wealth. (Toynbee, 1884, p. 64.)

But what joins competition to industrialization is innovation: this connection is registered in the text through the symbolic figures of Adam Smith and James Watt:

> The world was, in fact, on the eve of an industrial revolution; and it is interesting to remember that the two men who did most to bring it about, Adam Smith and James Watt, met in Glasgow, when one was dreaming of the book, and the other of the invention, that were to introduce a new industrial age. (Toynbee, 1884, p.204.)