SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2022
ORGANIZATION AND MANAGEMENT SERIES NO. 157

HISTORICAL ASPECTS OF MANAGEMENT, TECHNOLOGY, INNOVATION AND ECONOMIC GROWTH IN GREAT BRITAIN

Norbert KAWĘCKI

Maria Curie-Skłodowska University in Lublin, Poland; norbert.kawecki@googlemail.com,
ORCID: 0000-0003-1079-6600, PhD Student

Purpose: The purpose of the work is to present historical aspects of management, technology, innovation and economic growth in Great Britain based on international literature and articles.
Design/methodology/approach: Due to the cognitive nature of the work, the aim of the work will be achieved using the method of analyzing the literature and overview international articles to present results on the subject. Literature studies includes only foreign publications.
Findings: Historical aspects of management, technology, innovation and economic growth in Great Britain is widely described in international and British literature. Many articles provided value information's and researches to get to the conclusions and summary. Based on the reliable results scientist assess every aspects of provided subject.
Originality/value: The analysis international and British literature and articles shows all aspects of historical management, technology, innovation and economic growth in Great Britain and helps to improve knowledge and assessment of past to present and to predict future.

Keywords: Management, Technology, Innovation, Economy, Growth, History.

Category of the paper: Research paper.

1. Introduction

Great Britain, and England in particular, became one of the most prosperous economic regions in Europe between 1600 and 1700, Industrialization in the UK from the mid-eighteenth century resulted in economic developments described by many historians as the British industrial revolution. These developments resulted in Britain becoming one of the premier economies in Europe during the first half of the 19th century, the most prominent industrial power in the world economy, and a major political power (Baten, 2016, p. 13).

Economic growth can be driven in the short run by factor accumulation or by utilizing factors more efficiently, but permanent increases can only result from management to technological innovation. Given Britain's loss of industrial preeminence from the late nineteenth century, an absence in new technology formation is as natural an explanation for British failure as cultural interpretations that emphasize a weakness of the industrial spirit (Wiener, 1981, pp. 3-18). While Britain was the first "workshop of the world" its lagging position behind the technology frontier during the drive to industrial maturity is a topic of some debate in economic history. Accounts of technological progress during industrialization emphasize that Britain's rise was defined by capabilities in a broad array of industries and by a culturally enlightened and technically competent stock of human capital that could translate new ideas from home, or abroad, into commercially viable innovations (Mokyr, 2010, pp. 5-23).

It is a commonplace of management literature that Taylor, along with Fayol and Weber, was one of the principal architects of modern management (Cole, 1990, pp. 6-19). Drucker described scientific management as our most widely practiced personnel management concept and the most powerful contribution America has made to Western thought since the Federalist Papers and a popular text book on organizational. behaviour asserts that The influence of scientific management pervades management thinking and organization functioning in all industrialized countries of the world (Huczynski and Buchanan, 1991, pp. 277-278).

Before the late 18th century, per capita growth rates were either zero or miniscule and average per capita incomes in different regions of the world were quite similar (Galor, 2005, pp. 171-293). Galor and Weil (2000), Hansen and Prescott (2002) and Galor (2005) argue that this period of stagnation can be described as the Malthusian epoch. Instead of resulting in improved standards of living, technological progress led to increased population. However, with the onset of the Great Divergence was around 1760, on the eve of the First Industrial Revolution in Britain, the British economy began the transformation from the Malthusian trap to the post-Malthusian epoch during which the rate of technological progress outpaced the population growth drag, resulting in positive per capita growth rates. Yet the transformation of the British economy is still one of the great mysteries in the history of human evolution (Galor, Weil, 2000, pp. 806-828).

Economic growth literature contains extensive coverage of Britain due mainly to its preeminent position in the First Industrial Revolution and the availability of well-documented historical facts and data. However, despite being one of the most significant events in economic history, little is known about the role played by innovation in freeing the British economy from its Malthusian straightjacket. While the literature suggests different roles played by technology during the Industrial Revolution, technological progress has also been deemphasized as being important for the British growth experience by some economic historians (Madsen, Banerjee and Ang, 2010, p. 2). R.C. Allen notes that "recent research has downplayed the importance of technological progress and literacy in explaining the British industrial revolution"(Allen, 2003, p. 405). Furthermore, N.F.R. Crafts suggests that the augmented neoclassical growth model is the appropriate tool for modeling growth during the Industrial Revolution and that the most important innovations were exogenous during that period. Based on the statistical properties of productivity data, historiography and growth accounting exercises, N.F.R. Crafts concludes that both the AK model of Rebelo (1991) and the endogenous growth model of Grossman and Helpman (1990) are incapable of explaining the growth rates experienced by England during the Industrial Revolution (Crafts, 1995, pp. 745-772).

R.J. Sullivan describes the period 1762-1851 as the 'Age of Invention' for England' during which patentable inventions increased markedly (Sullivan, 1989, p. 424). D. Greasley and L. Oxley demonstrate that output fluctuations were very persistent during the period 1780-1851, and use this as evidence to argue that endogenous growth models are more relevant in accounting for the glorious period of Britain's industrialization than the neoclassical growth model. In a similar vein, using cointegration and causality techniques, L. Oxley and D. Greasley suggest that the Industrial Revolution was shaped mostly by technological progress (Greasley, Oxley, 1997, pp. 935-949).

N.F.R. Crafts and L. Oxley and D. Greasley focus on the validity of the first-generation endogenous growth models of Grossman and Helpman (1990) and Rebelo (1991) in explaining the Industrial Revolution (Madsen, Banerjee, Ang, 2010, p. 3). However, following C. Jones famous critique, the first-generation endogenous growth models are no longer acceptable to have any empirical validity. In particular, Jones notes that the number of R&D workers increased substantially during this period, while the US post-WWII growth rates have remained relatively constant. This observation is inconsistent with the predictions of the first-generation endogenous growth models that productivity growth is proportional to the number of R&D workers (Jones, 1995, pp. 495-525).

The second-generation endogenous growth models overcome this unwarranted property of the first-generation growth models by abandoning the assumption of constant returns to scale in ideas production (semi-endogenous growth models) or by assuming that the effectiveness of R&D is diluted due to the proliferation of products when an economy expands .Thus, given the shortcomings of first-generation endogenous growth models earlier findings based on them, the second-generation endogenous growth models may be more consistent with the British growth experience since 1620. However, it remains to be seen whether any of those modern innovation-based growth models, extended to allow for population growth drag, are capable of explaining the glorious period of Britain's industrialization (Madsen, Banerjee, Ang, 2010, p. 3).

2. Industrial Research and Management Practices

In an important study, D. Edgerton and S. Horrocks document the early history of R&D in Britain. They maintain that British firms invested quite heavily in in-house R&D, especially in the chemicals industry. Networks of technical experts facilitated spillovers of technological knowledge which were also promoted by inter-firm linkages. An early contributor to the British R&D effort was United Alkali which had centralized R&D as early as 1892 (Edgerton and Horrocks, 1994, pp. 213-238). Firms like ICI (formed in 1926 as a merger of United Alkali and three other chemicals companies), GEC and Metropolitan-Vickers were R&D pioneers, a point noted in Hannah's (1976) work on the rise of the corporate economy (Hannah, 1976, pp. 4-19). D. Edgerton and S. Horrocks' revisionist evidence represents a counter to D. Mowery's traditional argument that British R&D was weak (Mowery, 1986, pp. 4-25) and A. Chandler's implicit assertions that British firms also failed to generate large returns from R&D because they underinvested in the complementary capabilities of production, distribution and management (Chandler, 1990, pp. 3-10).

In line with the revisionist view, there is anecdotal evidence to show that British R&D could be innovative and well-managed. T.C. Barker's study shows how Pilkington developed the Float Process after extensive R&D over a decade, which was facilitated by family ownership and 15 control of the company and a commitment by the company to harnessing applied science and technology. Another prominent example of British success is the pharmaceuticals and biologics industry, where Glaxo-Wellcome, Smithkline-Beecham (these two companies merged in 2000 to form GlaxoSmithKline) and AstraZeneca have created a portfolio of some of the world's best known drug innovations such as Tagamet, Zantac and Nexium for the treatment of gastrointestinal problems. Equally there is anecdotal evidence of British R&D failure. Notably the British inventor Geoffrey Hounsfield, a scientist employed at the Central Research Laboratories of EMI, developed the profoundly significant CT Scanner, but EMI did not have the managerial capabilities to keep pace with demand. During the 1970s and 1980s it lost out to organizationally efficient U.S. companies like Technicare and General Electric (Barker, 1977, pp. 2-15).

Beyond individual case studies, S.N. Broadberry and N.F.R. Crafts argue that a critical set of drivers of firm performance are related to industry structure and the operating environment more generally, and these in turn influence incentives and management capabilities. For example, the British regulatory environment during the interwar years tolerated collusion between firms and provided subsidies for incumbents, so competition was absent as a disciplinary device in product markets. Furthermore, labor unions created an unproductive bargaining situation and constrained the reallocation of resources from poorly to better performing firms, which had a strongly depressing effect on productivity (Bradberry and Crafts, 1992, pp. 3-10). It is well-known that if managers of incumbent firms do not face the threat of replacement then their preferences can tend towards the Hicksian "quiet life". On the other hand, competition can encourage innovation especially if firms are already close to the technological frontier. In this case, firms have more incentives to invest in R&D to capture the incremental profits deriving from innovating (Aghion et al., 2005, pp. 701-728).

The notion that such factors were influential in Britain's more recent innovation performance is evidenced by the uptick in productivity as a consequence of more favorable competitive dynamics in British business. Deregulation, the liberalization of capital markets, better industrial relations standards and the strengthening of legislation with respect to product market competition all had positive effects (Crafts, 2012, pp. 17-29). At the same time, it is worth noting British weaknesses in the management and diffusion of technology still persist. Insofar as the main determinants of rapid TFP advance are the diffusion of innovations and the effectiveness of factors that affect the efficiency with which new technologies are used (Comin and Hobijn, 2010, pp. 2031-2059), the evidence suggests a large gap exists between Britain and the United States. N. Bloom and J. Van Reenen find that competition in recent years is still relatively milder in Britain than in the United States and when combined with the preponderance of British family firms, this has led to a prominent and persistent tail of badly managed medium-sized firms (Bloom and van Reenen, 2007, pp. 1351-1408). Among larger firms, N. Bloom, R. Sadun and J. Van Reenen find that U.S. multinationals operating in Europe were far more able to benefit from technology diffusion as manifested in the implementation of ICT advances compared to otherwise equivalent European firms. Weaker diffusion and inept management practice capabilities help to explain performance defects, although in a Europe wide context, these are not uniquely British problems (Bloom, Sadun, van Reenen, 2012, pp. 3-24).

3. Examples of history statistics in United Kingdom

The United Kingdom is particularly interesting as it was the first economy that achieved sustained economic growth and thereby previously unimaginable prosperity for the majority of the population (Roser, 2021).

The first part is the very long time in which the average person was very poor and human societies achieved no economic growth to change this. Incomes remained almost unchanged over a period of several centuries when compared to the increase in incomes over the last 2 centuries. Life too changed remarkably little. What people used as shelter, food, clothing, energy supply, their light source stayed very similar for a very long time. Almost all that ordinary people used and consumed in the 17th century would have been very familiar to people living a thousand or even a couple of thousand years earlier. Average incomes (as measured by GDP per capita) in England between the year 1270 and 1650 were £1,051 when measured in today's prices (Roser, 2021).

The second part is much shorter, it encompasses only the last few generations and is radically different from the first part, it is a time in which the income of the average person grew immensely – from an average of £1051 incomes per person per year increased to over

£30,000 a 29-fold increase in prosperity. This means an average person in the UK today has a higher income in two weeks than an average person in the past had in an entire year. Since the total sum of incomes is the total sum of production this also means that the production of the average person in two weeks today is equivalent to the production of the average person in an entire year in the past. There is just one truly important event in the economic history of the world, the onset of economic growth (Roser, 2021).

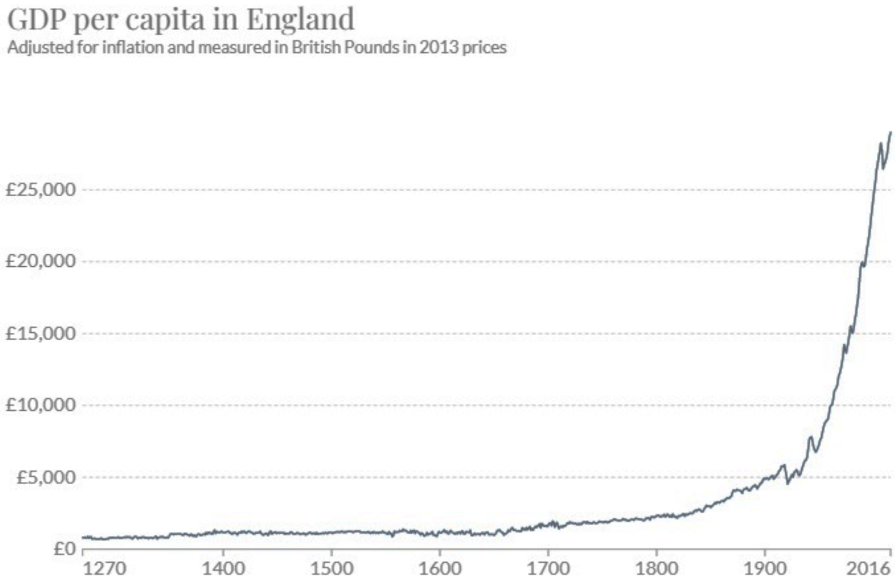

Figure 1. GDP per capita in England. Source: Bank of England 2020.

S. Broadberry, B.M.S. Campbell, A. Klein, M. Overton and B. van Leeuwen presented in his work output of key industries in England in years 1270 to 1870. All key industries have developed and increased since it had begun. Although printed books started by end of 1400's it showed the biggest increase through all centuries. Iron, Metals and Mining are on the top of increase per capita by late 1870's.

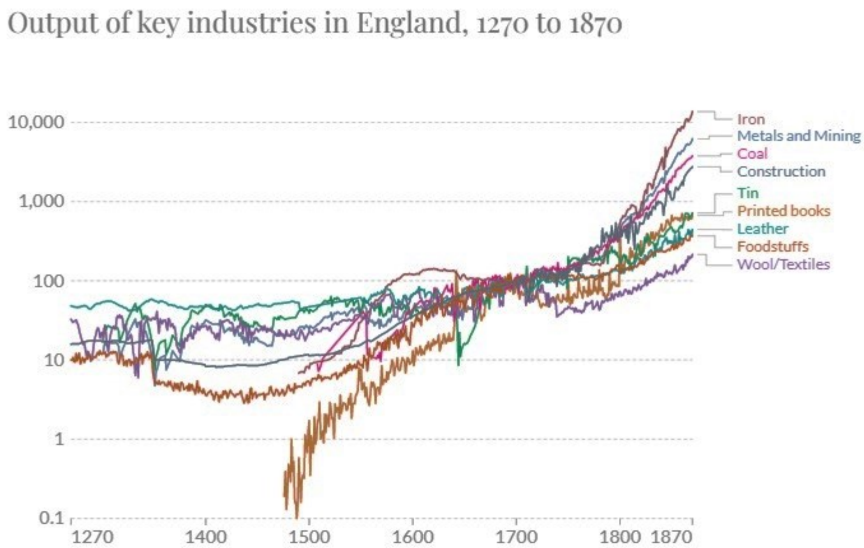

Figure 2. Output per capita in England. Source: Max Roser, Economic Growth, https://ourworldindata.org/economic-growth, access date 28.12.2021.

Bank of England (2017) presented nominal wages, consumer prices and real wages in United Kingdom from 1750 to 2013. Until 1950 the lines are quite linear with some small increase. From around 1950 increase of nominal and real weekly wages speeds up rapidly and increase of consumer prices are going high too.

Figure 3. Nominal wages, consumer prices and real wages in United Kingdom from 1750 to 2013. Source: Bank of England 2017.

United Kingdom from 1750 to 1830 has increasing share in World Manufacturing Output. From 1830 to 1900 the share is growing comparing to other countries with some dominance close to 1900's of United States.

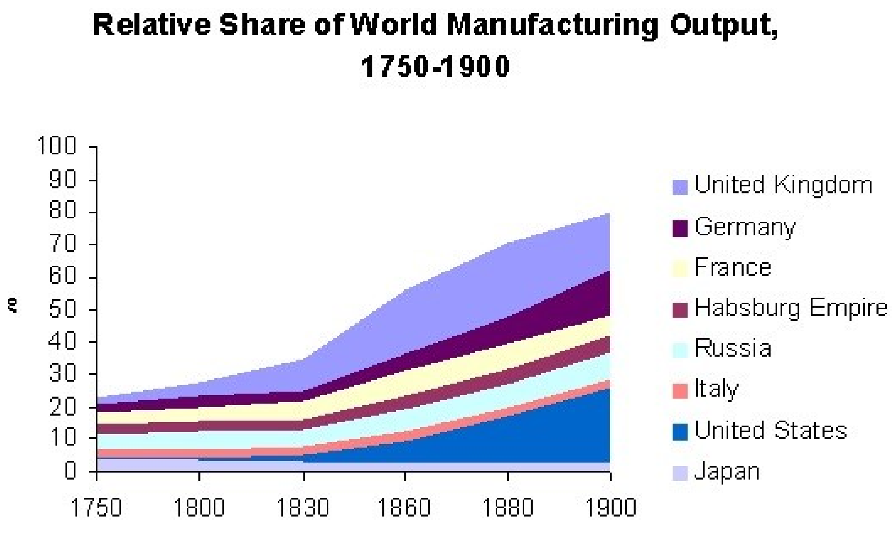

Figure 4. Relative Share of World Manufacturing Output 1750-1900. Source: https://en.wikipedia.org/wiki/Economic_history_of_the_United_Kingdom, access date 28.12.2021.

Levels of industrialization for United Kingdom compering to other countries is increasing tendence and from 1830 it becomes "rollingcoster".

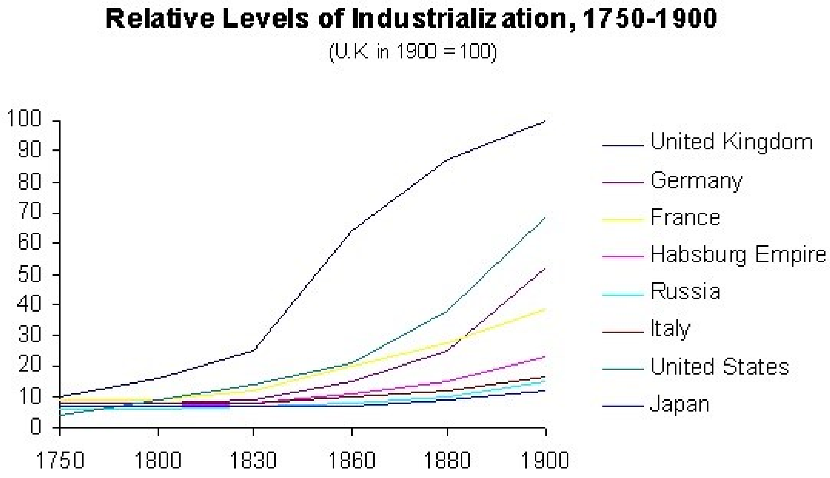

Figure 5. Relative Levels of Industrialization 1750-1900. Source: https://en.wikipedia.org/wiki/Economic_history_of_the_United_Kingdom, access date 28.12.2021.

4. Finding the right economy and technology policies for the Great Britain

The national and global landscapes have changed significantly since the events in these histories: for instance, since the creation of the DSIR in 1916, the Rothschild report, or since Thatcher's abandonment of 'near-market' research. The UK's 80% services-based economy, the social and economic contours of the UK's regional landscape, the recent reorganisation of the research councils under UKRI, and the changes in the UK workforce that will come with Brexit, are all pressures and needs that demand consideration in the formulation of science policies today, and they take on a different character to the challenges of the past. The history of science policy nevertheless offers valuable lessons and trends for policymakers today. They are listed below (Flanagan et al., 2019, pp. 6-8):

- **science policymakers must consider how science policies align with policy goals in other areas**. Science policy does not operate in a vacuum. It is related to other realms of policy such as economic policy, higher education policy, energy policy, agricultural policy and broader industrial policy. It is not restricted to research councils; research activities situated within or in close relationship to industry make up a sizeable portion of British R&D. Science policies should take this complex landscape into account. This also points to the fact that science policy cannot be an industrial strategy on its own. It should be situated within broader policy aims in other areas;

- **training people can build absorptive capacity**. 5 Science policies can play an important role in training people in research activities – practices, processes, and methods. As S. Clarke points out in her paper, such training is a vital way of bringing science and industry into a closer relationship. This training enables people and organisations to identify new scientific developments and innovations (that often may be external to them), integrate these into their work, and benefit from these developments by using that knowledge to meet their own needs and goals. In other words, it increases 'absorptive capacity';
- **absorptive capacity can help Britain benefit from a global R&D landscape**. Crucially, building absorptive capacity enables Britain to benefit from its relationship to the global landscape of R&D. D. Edgerton and K. Flanagan's papers both prompt consideration that the UK may only be best placed to pursue innovation at home in certain areas and, by contrast, may benefit from developing processes or innovations from abroad (or importing skills/products) in other areas. Britain has historically been very good at adopting other nations' innovations and must continue to invest in its own 'absorptive capacity' to benefit from them. Science policy should therefore not only foster innovations at home but also foster skills that enable external innovations to be identified, adapted, and utilised within Britain. A strong science base is key to the UK's ability to benefit from global developments in science and technology;
- **policies can have significant long-term effects that are hard to reverse**. J. Agar points out how, in the postwar period until the 1990s, R&D in the UK was mainly financed by government but performed by industry (and half was military in orientation), but from the 1990s to the present R&D in Britain has been mostly funded and performed in the private sector. In the 1960s, the proportion of GDP spent on R&D, public and private, peaked at around 2.3%. This dropped throughout the 1980s and 1990s to 1.8% by 1999, driven by reductions in both government and company spending. David Edgerton notes that from the late 1980s, research council spending was cut much less (in some cases this increased) relative to departmental research spending cuts. This also marked a shift away from publicly funded support for 'near market' R&D – 'basic' ('curiosity-driven') research was to be funded by government through the research councils, whereas 'near-market' ('applied') research was to be funded by industry. The important lesson here is that the impacts of these changes still manifest today. In 2016, for example, research councils had 61% of their budgets allocated to 'basic' research, though it is also likely that much of the 'applied' research funded by the UK research councils is closer to 'basic' research than to the technological development prioritised by other nations. Civil department R&D, on the other hand, was allocated largely toward 'applied' research and 'experimental development'. R&D in business is overwhelmingly orientated toward 'applied' research and 'experimental development'. The UK R&D landscape now continues to shift –

as Kieron and Flanagan points out, today research is once again seen as a key part of industrial strategy, whereas for the past few decades, as described by Edgerton and Agar, science and innovation policy has essentially been a substitute for industrial policy;

- **brokerage and ways of convening enable the identification of valuable science policies**. C. Craig's paper highlights the need for, and value of, ways of bringing the right people together to identify, frame, and work on solutions to science questions in a collaborative way. She notes that methods are one way of doing so because they create means for 'brokerage', enabling policymakers and experts/designers to engage with one another regarding the assumptions and limitations of a given method, for example. Formal structures such as the IPCC, or informal movement of exchanges of people through travel and migration, are other ways to create these infrastructures for brokerage. A related point that emerged in the seminar discussion was that, with these structures, there also needs to be a capacity for problems to be articulated from below (for example, smaller business and wider society, and not just the large companies in, must be given ways of effectively convening with other R&D players);
- **transparency and access to decision-making help to avoid mistakes.** J. Agar discusses the impact of a switch in science policy in 1987, when there was a pivot of government funding towards the science base (branded 'curiosity-driven research') alongside a cutting of government-funded 'near-market' support. He suggests that this switch essentially ended an active, interventionist, science-based, publiclyfunded industrial strategy. Greater openness and access to decision-making processes would have helped avoid this mistake;
- **internal expertise can help to facilitate brokerage.** A point that emerged from the seminar discussion was that internal scientific expertise in government can be valuable in that it provides a 'connective tissue' between different framings of science policy issues. Similarly, encouraging scientists and science policymakers to train in the history of science during their education, would provide them with a better understanding of how their expertise has been situated within policy, and has related to societal demands, needs, and influences outside (and within) the scientific institution;
- **policymakers need infrastructures that can overcome institutional memory.** Another point that emerged from the seminar was that lack of institutional memory in government poses a significant challenge for a policy area that demands an infrastructure of 'connective tissue'. These issues suggest that there need to be infrastructures in place that can manage knowledge about science policy as it travels and moves in and out of government. Thinking about this knowledge as also being embodied in individuals (who are changing posts or departments regularly), this points to the importance of convening across silos/departments/institutions as well as within.

5. Summary

The work has presented the literature on some historical aspects of management, technology, innovation and economic growth in Great Britain. Despite these areas in which Britain displayed competence and distinctiveness, the management of technology has typically been weak. Organizational economists have long argued that a strong complementarity exists between technology, management practices and the demand for skilled labor, which creates a much more complex nexus through which invention contributes to productivity growth. As presented by author in last chapter the main improvements should be implemented in areas: policymakers need infrastructures that can overcome institutional memory, internal expertise can help to facilitate brokerage, transparency and access to decision-making help to avoid mistakes, brokerage and ways of convening enable the identification of valuable science policies, policies can have significant long-term effects that are hard to reverse, absorptive capacity can help Britain benefit from a global R&D landscape, training people can build absorptive capacity, science policymakers must consider how science policies align with policy goals in other areas.

As the Great Britain history in all aspects shows it has been done a lot but permanent observation and improvement is required due to fast changing world. The history can be some base to build better presence and moving forward future.

References

1. Aghion P. et al. (2005). Competition And Innovation: An Inverted-U Relationship. *Quarterly Journal of Economics, 120, No. 2*, pp. 701-728.
2. Allen, R.C. (2003). Progress and Poverty in Early Modern Europe. *Economic History Review, 56(3),* p. 405.
3. Barker, T.C. (1977). *The Glassmakers: Pilkington: The Rise of an International Company, 1826-1976.* London, pp. 2-15.
4. Baten, J. (2016). *A History of the Global Economy. From 1500 to the Present*. Cambridge, p. 13.
5. Bloom, N., Sadun, R., Van Reenen, J. (2012). Americans do I.T. Better: US Multinationals and the Productivity Miracle. *American Economic Review*, pp. 3-24.
6. Bloom, N., Van Reenen, J. (2007). Measuring and Explaining Management practices Across Firms and Nations. *Quarterly Journal of Economics, 122, No. 4*, pp. 1351-1408.
7. Broadberry, S.N., Crafts, N.F.R. (1992). Britain's Productivity Gap in the 1930s: Some Neglected Factors. *Journal of Economic History, 46,* pp. 3-10.

8. Chandler, A. (1990). *Scale and Scope: The Dynamics of Industrial Capitalism*. Cambridge: Harvard University Press, pp. 3-10.
9. Cole, G.A. (1990). *Management: Theory and Practice.* London: DP Publications Ltd., pp. 6-19.
10. Comin, D., Hobijn, B. (2010). An Exploration of Technology Diffusion. *American Economic Review, 100, No. 5,* pp. 2031-2059.
11. Crafts, N. (2012). British Relative Economic Decline Revisited: The Role of Competition. *Explorations in Economic History, 49, No. 1*, pp. 17-29.
12. Crafts, N.F.R. (1995). Exogenous or Endogenous Growth? The Industrial Revolution Reconsidered. *Journal of Economic History, 55(4),* pp. 745-772.
13. Edgerton, D., Horrocks, S. (1994). British Industrial Research and Development Before 1945. *Economic History Review, 47, No. 3*, pp. 213-238.
14. Flanagan, K. et al. (2019). *Lessons from the History of UK Science Policy.* The British Academy, pp. 6-8.
15. Galor, O. (2005). From Stagnation to Growth: Unified Growth Theory. In: P. Aghion, S.N. Duraluf (Eds.), *Handbook of Economic Growth, Vol. 1, Part 1*, pp. 171-293.
16. Galor, O., Weil, D.N. (2000). Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and beyond. *American Economic Review, 90(4),* pp. 806-828.
17. Greasley, D., Oxley, L. (1997). Endogenous Growth or "Big Bang": Two Views of the First Industrial Revolution. *Journal of Economic History, 57(4),* pp. 939-945.
18. Hannah, L. (1976). *The Rise of the Corporate Economy.* London: Methuen, pp. 4-19.
19. Huczyński, A., Buchanan, D. (1991). *Organizational Behaviour*. Hemel Hemstead: Prentice Hall International, pp. 277-278.
20. Jones, C. (1995). Time Series Tests of Endogenous Growth Models. *Quarterly Journal of Economics, 110(2),* pp. 495-525.
21. Madsen, J., Banerjee R., Ang, J.B. (2010). Four Centuries of British Economic Growth: The Roles of Technology and Population. *Journal of Economic Growth, CAMA Working Paper 18,* p. 3.
22. Mokyr, J. (2010). *The Enlightened Economy: An Economic History of Britain, 1700-1850*. Yale, pp. 5-23.
23. Mowery, D. (1986). Industrial Research in Britain, 1900-1950. In: B. Elbaum, W. Lazoncks (Eds), *The Decline of the British Economy* (pp. 4-25). Oxford: Oxford University Press.
24. Roser, M. *Economic Growth*. Retrieved from https://ourworldindata.org/economic-growth, 28.12.2021.
25. Sullivan, R.J. (1989). England's "Age of invention": The Acceleration of Patents and Patentable Invention during the Industrial Revolution. *Explorations in economic history, 26(4),* p. 424.

26. Wiener, M. (1981). *English Culture and the Decline of the Industrial Spirit 1850-1990.* Cambridge, pp. 3-18.
27. Wikipedia. Available online https://en.wikipedia.org/wiki/Economic_history_of_the_United_Kingdom, 28.12.2021.