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„The British global hegemony 1763-1914 and energy.
The intricate nexus.“

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Abstract in English: This paper tries to address the question why access to energy resources is considered as an important factor for all the great powers. Intellectually inspired by books and papers written in the fields of global history and international relations which are focused on a role of energy and the paper looks at the role of coal for the British empire. Thesis is therefore divided into two main parts. Firstly, the notion of hegemony is examined through literature review. In the second part I look at important developments in history of technology that could make the Empire more powerful than its competitors, taking energy oriented perspective. According to this thesis the history of British domination – the first modern global power – is divided in two periods. The first part investigates the period of pre-modern global hegemonic wars i.e. 1763-1830 while the second part spans 74 years, between 1830 and 1914. The decade of 1830s is taken as a marking point dividing the examined period as the real industrialization of war began then, not before. However, as the Empire's position was built in pre-modern times, it should be considered as the last pre-modern empire. Hence, the industrialization of warfare should be seen as process which sustained, yet not created, British domination. Thus, it seems to be wrong to consider British empire as coal-based. Finally, two assumptions are proposed, namely, (1) easy access energy is necessary but not sufficient condition for an industrial great power; (2) cheap energy provide capabilities for quantitative (yet not qualitative) advantage for a state endowed with vast energy resources.

Abstract in German: Diese Arbeit versucht die Frage zu beantworten warum Zugang zu Energieressourcen als ein wichtiger Faktor für alle Großmächte angesehen wird. Inspiriert ist diese Arbeit von Büchern und Arbeiten, die in den Feldern Globalgeschichte und internationale Beziehungen in Bezug auf die Rolle von Energie geschrieben wurden, und beleuchtet die Rolle von Kohle für das Britische Weltreich. Diese Arbeit ist daher in zwei Hauptteile gegliedert. Erstens wird die Auffassung von Hegemonie mit Hilfe einer Literaturrecherche untersucht. In einem zweiten Teil untersucht der Autor wichtige Entwicklungen in der Geschichte der Technologie aus dem Blickwinkel von Energie heraus, welche dem Imperium zu einem Machtvorteil gegenüber ihren Konkurrenten verhalf. Diese Arbeit geht davon aus, dass die Geschichte der britischen Dominanz – die erste moderne Weltmacht – in zwei Perioden geteilt ist. Der erste Teil untersucht die Periode der vormodernen Kriege um die globale Hegemonie zwischen 1763 und 1830, während der zweite Teil die 74 Jahre zwischen 1830-1914 umfasst. Die Dekade der 1830er Jahre wird als Wendepunkt angesehen der die untersuchte Periode teilt, da die wirkliche Industrialisierung des Krieges erst ab diesem Zeitpunkt begann. Da sich die Position des Imperiums aber in vormoderner Zeit entwickelte, sollte es als das letzte vormoderne Imperium angesehen werden. Daher sollte die Industrialisierung des Krieges als ein unterstützender Faktor angesehen werden, und nicht als einer, der die britische Dominanz begründet hat. Somit scheint es falsch zu sein, dass das Britische Empire als ein auf Kohle basierendes Imperium anzusehen ist. Zuletzt werden zwei Schlussfolgerungen vorgeschlagen. Erstens, das einfacher Zugriff auf Energie zwar notwendig ist, aber keine ausreichende Bedingung für eine industrielle Macht darstellt. Zweitens, das billige Energie einen quantitativen (aber nicht qualitativen) Vorteil für einen Staat der mit großen Energie Ressourcen ausgestattet ist, ermöglicht.

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1) Introduction

A quest for domination, in other words, how one polity can influence or even dominate behaviour of other polities has remained one the main questions addressed by scholars and philosophers for centuries. To make such domination possible a polity must possess certain capabilities and, usually, military power is to be considered as the most important. While that is certainly true, one has to admit it is not enough. As Kennedy argues “the historical record suggests that there is a very clear connection in the long run between an individual Great Power's economic rise and fall and its growth and decline as an important military power.”¹ This thesis has been intellectually inspired by books and papers written in the fields of global history and international relations which are focused on a role of energy. While both explore the topic and are complementary, in the author's opinion, they lack a connection and do not provide a clear answer to how easy access to energy resources makes some societies more powerful than others.

Can energy be the sole agent of history? Unquestionably not because if this had been the case, Saudi Arabia or Russia would have initiated the Industrial Revolution. Exploitation of energy resources requires adequate knowledge, capital stock and an economic incentive to dig them up - and all of these are institution-dependent. It has led to emergence of theories suggesting that institutions are solely responsible for trajectories of human development.² Furthermore, if any author puts stress on material preconditions for development, he or she is usually called “Malthusianistic” and disregarded as proved to be false due to breakdown of the Malthusian trap during the Industrial Revolution. Hence, energy had not been recognized as a critical factor in human development before its prices became really high.

1

Paul Kennedy, *The Rise and Fall of the Great Powers: Economic Change and Military Conflict from 1500 to 2000* (London: Unwin Hyman, 1988), p. 22.

2 Daron Acemoglu, Simon Johnson and JA Robinson, “The Colonial Origins of Comparative Development: An Empirical Investigation,” *American Economic Review*, 91 (2001), 1369–1401; Daron Acemoglu, S Johnson and JA Robinson, “Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution,” *The Quarterly Journal of Economics*, 2002

Energy, by itself, is useless without energy converters. In other words, without proper converters, energy remains only the potential to change which must be somehow freed, not the change itself. Hence, the Industrial Revolution can be defined as the epochal change from living to mechanical energy converters. Even if technology was important in pre-modern times (i.e. windmills, watermills etc.) this notion is usually connected with rapid progress in mechanical metal-based industrial technology and its expansion since the 18th century. The ubiquitous presence of technology has led to emergence of a narrative seeing it as an autonomous agent of change. Hence “an invention, once introduced into society, is thus depicted as taking on a life of its own. (...) The whole network, a system of systems, or a megasystem becomes the indispensable technological armature of the economy. Its continued functioning is a precondition for the reproduction of the entire social order.”³ Accordingly, famous philosopher Karl Marx once wrote, “the hand-mill gives you society with the feudal lord; the steam-mill, society with the industrial capitalist.” What it implies is very simple, a long-term relationship between social and mechanical structures. The claim that no other changes, i.e. in social or political structure, are to be seen when technology evolution is on the way, seems to be too simplistic.

Heilbroner, the author of the 1967 famous essay “Do machines make history?”, states explicitly in the revisited edition of the paper that “machines make history by changing the material conditions of human existence.”⁴ Moreover, as Karl Marx wrote more than one and a half of century ago “when you have once introduced machinery into the locomotion of a country, which possesses iron and coals, you are unable to withhold it from its fabrication. You cannot maintain a net of railways over an immense country without introducing all those industrial processes necessary to meet the immediate and current wants of railway locomotion, and out of which there must grow the application of machinery to those branches of industry not immediately connected with railways.”⁵ Even if he is not completely right, as the case of India shows, enormous impact of newly introduced industrial technologies on a society is clear. What is omitted in this analysis is that

3 Merritt Roe Smith and Leo Marx, *Does Technology Drive History?: The Dilemma of Technological Determinism* (MIT Press, 1994), p. X.□

4 Smith and Marx, p. 67.

5 Karl Marx, “The Future Results of British Rule in India”
<http://www.marxists.org/archive/marx/works/1853/07/22.htm> [accessed 3 October 2013].

relation between iron and coal and new technologies is recognized on the state level only.

Thus, while research addresses partially socio-political issues triggered by technology, the question becomes even more complicated when we try to investigate the role of technology and energy for the change on international level. Herrera, trying to develop a theoretical approach to technology in the field of international relations, argues that physical artefacts and social practices make “technology.” Certainly, it is hard not to agree with him that both, pure “determinism (the material characteristics of the technology determine the political results) and instrumentalism (politics governs the development and use of new technologies)” seems to be too limited. However, his considerations lead him to a vague statement that technology evolves as “transnational sociopolitical process linked by the mechanisms of emulation and diffusion.”⁶ Firstly, as it is often the case when it comes to general statements, it can be questioned due to the fact that the steam engine was the British invention. Secondly, it does not take into account differences between various kinds of technology. Although the key ones – like trains he referred to in his books – were developed in the transnational context, it was impossible to produce them and make them function without cheap energy. Hence, as energy markets are relatively new development, the backbone of railroads – vast energy resources, was national, not transnational issue. While these ideas contribute to understanding of the role of technology, they seem not to have too much value when it comes to energy. Moreover, as it was shown by Dannreuther, none of contemporary international relations theories – which should provide us such theoretical background - approach the topic in a comprehensive way.⁷

Therefore, it is necessary to employ a more general theory which attempts to clarify the role of material conditions for quest for power in a very general sense. The idea of linking material contexts and security-political arrangements which is called historical security materialism, emerged in the 19th century from the trunk of older naturalist materialism. However, any single material factor – not geography nor technology – can be considered separately. Hence, energy deposits do not constitute great power by themselves but what is necessary are means of

6 G. L. Herrera, *Technology and International Transformation: The Railroad, the Atom Bomb, and the Politics of Technological Change*, 2006

7 Roland Dannreuther, “International Relations Theories : Energy , Minerals and Conflict,” *POLINARES working paper n. 8*, 2010.

conversion of energy into material tool of violence. “Thus, combinations of particular geographies and technologies together constitute the material context. Furthermore, communication and transportation are as integral to the forces of destruction as are specifically destructive technologies in shaping both the velocity and volume of violence available in particular material contexts.”⁸

Hence, based on the combination of material forces and technology available as key factors, four broad epochs in human history are to be found: “(1) Pre-modern (to 1500) composed of horses and camels, sails and oars, and bows and catapults; (2) Early modern (1500-1850) composed of horses and camels, ocean sailing and navigation, and gunpowder; (3) Global-Industrial (1850-1945) composed of steel ships powered by coal and oil, airplanes, telegraphs and radio, and high explosives; and (4) Late Global or Planetary-Nuclear (after 1945) composed of jet airplanes, rockets and missiles, satellites and nuclear explosives.”⁹ Yet, there is not enough stress put on the qualitative and quantitative change in terms of war capabilities between early modern period and the global-industrial one. While various sources of energy, namely coal, oil and sails are mentioned as factors they have not been not investigated by the author.

Thus, this paper tries to contribute to the debate by bringing together research from two fields, international relations and global economic history. Firstly, there is growing body of literature on global economic history which examine the role of energy for the take-off of modern economic growth. Several distinguished scholars have stressed the role of coal as an important factor in the creation of the Industrial Revolution in Britain.¹⁰ Secondly, the field of international relations argues that the global domination is temporary in character. In other words it is to be changed under certain circumstances and these conditions are subject of academic research. This paper attempts to determine whether energy, being a main driver of economic growth, may be a cause of change in global leadership.

8 D. Deudney, “Geopolitics as Theory:: Historical Security Materialism,” *European Journal of International Relations*, 6 (2000), 77–107 (p. 90) <doi:10.1177/1354066100006001004>.

9 Deudney, p. 89.

10 Robert C. Allen, *The British Industrial Revolution in Global Perspective* (Cambridge University Press, 2009); Kenneth Pomeranz, *The Great Divergence: China, Europe, and the Making of the Modern World Economy* (Princeton University Press, 2001); Edward Anthony Wrigley, *Energy and the English Industrial Revolution* (Cambridge University Press, 2010); RP Sieferle, *The Subterranean Forest: Energy Systems and the Industrial Revolution*. (The White Horse Press, 2001).□

The topic fits into a broader debate about the causes of a change in international politics. Scholars related to world-systems theory look for inherent political and economic dynamics as causes of change and argue that international systems run in predictable patterns.¹¹ While hegemony is an outcome of a combination of economic and military superiority, it is challenged by rising powers with more effective economies, more innovative technologies or better political organization. Hence, economic superiority is an important factor in a position of a state in the international order. As the body of research showing importance of energy for economic growth is growing¹² it is important to ask whether energy can also be a factor in political change.

Very little research on this topic has been conducted albeit two papers specifically focused on energy and the quest for power have been produced recently. LePoire's examinations of "long-term population, productivity, and energy use trends in the sequence of leading capitalist nations" does not bring anything new to the stage. He does not provide any clear argument how energy influences global hegemony cycles except for the vague statement that "the energy use transitions may not follow the national leadership transitions."¹³ Podobnik observes that intensity of geopolitical rivalry was related to energy transitions. Yet, again, no clear link between these two is made.¹⁴ Hence, both of them do not explore the topic deeply enough.

Because of this lack of a clear framework, an attempt to sketch a such is made here. I would argue that, even if a state has access to energy resources, it needs intermediary means to translate potential provided by deposits into material artefacts used to project political and military power. These are, in my opinion, (1)

11 Robert Gilpin, *War and Change in World Politics* (Cambridge University Press, 1983); George Modelski, *Long Cycles in World Politics* (University of Washington Press, 1987); AFK Organski, *World Politics* (New York: Knopf, 1968); Joshua S Goldstein, *Long Cycles: Prosperity and War in the Modern Age*, 1988.

12 Among the papers on the topic are: Robert Ayres and B. Warr, *The Economic Growth Engine: How Energy and Work Drive Material Prosperity* (Edward Elgar Publishing, 2009); Paolo Malanima, "Energy in History," in *Encyclopedia of Life Support Systems*, 2010; David I Stern, "The Role of Energy in Economic Growth.," *Annals of the New York Academy of Sciences* (Canberra, 2011), 26–51 <doi:10.1111/j.1749-6632.2010.05921.x>; Kenneth Rogoff, "Oil and the Global Economy", 2006; H.T. Odum, "Energy, Ecology, and Economics," *Ambio*, 2 (1973), 220–227; Joshua S Goldstein, Xiaoming Huang and Burcu Akan, "Energy in the World Economy, 1950 – 1992," *International studies quarterly*, 41 (1997), 241–266; James D Hamilton, "Oil Prices, Exhaustible Resources, and Economic Growth," *NBER Working paper*, 2012; James D Hamilton, "Oil and the Macroeconomy Since World War II," *The Journal of Political Economy*, 91 (1983), 228–248; James D Hamilton, "Historical Oil Shocks", 2011.□

13 David J. LePoire, "Long-Term Population, Productivity, and Energy Use Trends in the Sequence of Leading Capitalist Nations," *Technological Forecasting and Social Change*, 77 (2010), 1303–1310 <doi:10.1016/j.techfore.2010.05.003>.□

14 Bruce Podobnik, "Toward a Sustainable Energy Regime: a Long-Wave Interpretation of Global Energy Shifts," *Technological Forecasting and Social Change*, 172 (1999), 155–172.

technological capacity (including stock of knowledge) of a state and (2) its institutions. In other words, a combination of material capabilities and human abilities is a must for effective utilization of energy resources. To a certain extent, an assumption can be made that social structures remained quite stable in Britain during the given period. Not only British labour was well educated¹⁵ but economic institutions were also conducive toward economic growth.¹⁶ Thus this piece of research is focused on material capabilities. Headrick makes the point that Western imperialists in late the 19th century were not more motivated than their predecessors. Hence, arguing for an unchanging character of human behaviour; which is competitive and aggressive; he goes along the way of thinking presented by the realist school in international relations. Therefore, as there was a technological balance between East and West until the beginning of the 19th century, one should look at the sources of rapid conquests in technological progress which provided advantage for Europeans. Application of steam and iron to riverboats and constant improvements in firearms enhanced power projection capabilities. "Steamships, railways, and telegraphs allowed Europeans to control their newly acquired colonies efficiently."¹⁷ Therefore, this thesis considers technological aspect of power and its connection to energy as a very important factor in the competition for dominance in the international realm.

Trying to answer the question whether coal was important for British hegemony, this paper is divided into two main parts. Firstly, the notion of hegemony is examined through literature review. I aim to answer if and when British hegemony occurred. In the second part I analyse important developments in history of technology that could make the Empire more powerful than its competitors from energy point of view. In other words, I ask whether they were connected to abundant British coal deposits. Firstly, it investigates the evolution of the Royal Navy between 1763 and 1830s. The second section examines the structure of the British taxation system in the times of global hegemonic wars at the turn of the 18th and 19th centuries to look whether more easily taxable manufactured goods, produced in steam-powered factories, were important for the budget. Subsequently, history

¹⁵ Allen, p. 53.

¹⁶ Douglas C North and Barry R Weingast, "Constitutions and Commitment: The Evolution of Institutions Governing Public Choice in Seventeenth-Century England," *The journal of economic history*, 49 (1989), 803–832.□

¹⁷ Daniel R. Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850–1940* (Oxford University Press, 1988), pp. 5–6.

of British ships, firearms, railways and telegraphs since around 1830's are reviewed. While the general conclusion is that these developments certainly helped Britain to gain advantage over non-European societies, it is not the case when it comes to the rivalry with other Europeans who stayed, more or less, on par with British when it comes to technological progress.

Few words should be said about why 1830s were chosen as the turning point. One can arguably say that until then, the influence of the Industrial Revolution for the quest for power was negligible. McNeill argues that the application of technologies brought by the Industrial Revolution to military routines started in 1840s. "In the 1840s the Prussian army and the French and British navies broke away from the weapons pattern that had served European governments of the Old Regime so well."¹⁸ Naval designs were fundamentally transformed through the application of steam engine, screw propellers and turbines while the construction of vessels was improved through the introduction of iron cast parts.¹⁹ In 1830s first British steamships were sent far overseas – in 1832 to Africa and in 1834 to Americas. Moreover, a steamship was built overseas - in Calcutta - and sent to China. In 1839 the construction of the *Nemesis*, a steamship that strongly influenced the First Opium War, was launched.²⁰ The second important conflict in this period was the Crimean War, won through superior supply and superior rifled handguns, both dependent on production of the technological advantage and application of steam-power. While the rifles design was also substantially improved in late 1840s by the invention of a new shape of bullets.²¹ In the US interchangeable weapons were produced in two different factories for the first time in 1834.²² Therefore, "it is beyond dispute that the rate of weapons development has accelerated remarkably since approximately 1830."²³ The new technologies of transport – not only steamships but also railways – which spread quickly since 1830, radically increased possibilities for power projection as they could move forces into

18 William Hardy McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000* (University of Chicago Press, 1982), 222,223.□

19 R Harding, *Seapower and Naval Warfare, 1650-1830* (UCL Press, 2001), p. 4.□

20 Headrick, "The Tools of Imperialism: Technology and the Expansion of European Colonial Empires in the Nineteenth Century", p. 239,240.□

21 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, 230–232.□

22 Richard N. Cooper and Vernon W. Ruttan, *Is War Necessary for Economic Growth? Military Procurement and Technology Development* (Oxford University Press, 2006), p. 25 <doi:10.2307/20032161>.

23 Robert L. O'Connell, *Of Arms and Men : a History of War, Weapons, and Aggression*, (1989), p. 9.□

conflict zones and sustain them for long periods.²⁴ Thus, the real industrialization of war began in 1830s, not before.

It can be argued with a level of certainty that British dominance was unrelated to coal. The plausible peak of the Empire's power occurred in the first half of the 19th century when the level of direct application of industrial processes to global politics was relatively low. What is striking, when a revolution in military affairs was speeding up and other European countries were catching up in the second half of the 19th century, Britain began to lose its position. In other words, British were progressive when it comes to economics but not warfare. However, to be fair, a number of reservations must be made. As a relatively small society they built power based on economy and control of choke points. They would not be able to confront Russians or Chinese in a full-scale battle. Moreover, warfare seems to be more complicated than a purely economic activity. It requires material artefacts and people (both of which must be supplied in necessary amount) delivered and coordinated at right time and space. It might have been easier for the British to build small but efficient economy than to translate its products into global full-scale warfare. Hence, size does matter. The last thing is that big technological discrepancies between neighbouring societies do not persist indefinitely. "The industrial revolution was a transnational and competitive process, and the British monopoly did not last long. A home market saturated with railroads and an overabundance of skilled engineers drove large numbers of them out of Britain in the 1820s and 1830s."²⁵ While Britain had unique conditions that encouraged application of energy for economic activity it was not the same when it comes to warfare. As history shows relations between societies are driven by competitive self-interest, hence, all pursue technologies that could provide advantage in warfare.

This statement may go too far but one may even argue that the world-scale industrialization was detrimental for Britain whose power in the international realm, was built in the late 18th century and was de facto pre-modern. In other words, this paper suggests that Britain was not the first industrial global power. It was the transitional one.

²⁴ Jeremy Black, *Introduction to Global Military History: 1775 to the Present Day* (Routledge, 2005), p. 53.□

²⁵ Herrera, p. 9

2) Defining hegemony.

2.1. What does hegemony mean?

Hegemony is a word rooted in Greek language and comes from “hegemonia” which literal meaning is “leadership”. Therefore the state described with this notion is primary one or ‘leading state’ in a given, hierarchically organized, group. Hence, hegemony needs environment as point of reference. The mix of different power resources gives a hegemon “structural power” to lead the system. It also makes it far more possible that hegemon will get desirable outcome without using in coercive manner means it has in possession.²⁶ Furthermore, hegemon does not need to conquer the whole core in which it operates. It is enough when it is more powerful economically and militarily than the other states in the core.²⁷ Attributes which makes hegemon stronger than other states are “a large, growing economy; dominance in a leading technological or economic sector; and political power backed up by military power.”²⁸

Recently, with the growing interest in social aspects of power, new definitions have been made. For example, Clark argues that hegemony means “an institutionalized practice of special rights and responsibilities conferred on a state with the resources to lead”. What is more, this does not necessarily reliance on overwhelming dominance of a state. It is rather status bestowed by others based on general recognition. In other words it is a consensual legitimacy. It fits to broader view of hegemony assuming that it is an accepted institution of international society. Hence typology of hegemony is recast, basing on international society approach to international relations. Concentrating upon the dynamics of legitimacy he distinguished three types of hegemony: (1) collective hegemony represented by the Concert of Power in the 19th century; (2) singular – yet functionally limited – hegemony of Britain; (3) coalitional hegemony of the United States from 1945 until the

26 Martin Griffiths and Terry O’Callaghan, *International Relations: The Key Concepts* (Routledge, 2001), pp. 137–138.□

27 C Chase-Dunn, Peter Taylor and Giovanni Arrighi, “Hegemony and Social Change,” *Mershon International Studies Review*, 38 (1994), 361–376, (p. 362).□

28 Griffiths and O’Callaghan, p. 136.□

early 1970s. Being deeply anchored in institutional perspective Clark argues that these historical examples show embodiment of these hegemonies in different institutional settings.²⁹ Yet, being focused on socially constructed hegemonies Clark misses their material foundations. Hence this perspective is useless for this paper as energy is part of material, not social capabilities, of a state.

Hegemony in its material sense is tightly connected to the notion of power which is the matter of concern of the scholars working in realist tradition of international relations. The body of research on this topic is usually divided into two branches – systemic and realist streams, each containing two theories. Systemic approaches consists of world economy theory (hegemon seen as dominant economy primarily) and long-cycle theory (hegemon seen as possessor of preponderance of naval power). The realist variant includes hegemonic stability theory (hegemon as rational actor which provides public goods for the system) and power transition theory. What differs these two main approaches is the level of analysis. While systemic variants analyse global structures and dynamics, realist approaches remain concentrated on state level. In the latter case the risk is dynamics on world scale can be omitted.³⁰ Yet, the differences between these approaches are blurred. For example Organski's Power Transition theory is seen as a part of systemic variant³¹ while Lebow³² treats Robert Gilpin's book "War and change in world politics" as a part of power transition stream instead of hegemonic stability theory – where it is usually attached.³³ In my opinion systemic theories cannot be used in this paper as they explore dynamics and logic of change in international political system while the aim of current work is to look at the capabilities, rationale and activities of Britain solely.

The only reasonable theory that can be applied is hegemonic stability theory which is of realist in kind and focuses on state as the unit of analysis and relative advantage of hegemon over competitors. The approach

29 Ian Clark, "Bringing Hegemony Back in: The United States and International Order," *International Affairs*, 1 (2009), 23–36 (pp. 33–34)□

30 T Boswell and M Sweat, "Hegemony, Long Waves, and Major Wars: A Time Series Analysis of Systemic Dynamics, 1496-1967," *International Studies Quarterly*, 35 (1991), 123–149.□

31 Goldstein, pp. 118–122.

32 R. N. Lebow and B. Valentino, "Lost in Transition: A Critical Analysis of Power Transition Theory," *International Relations*, 23 (2009), 389–410 (pp. 390–391) <doi:10.1177/0047117809340481>.□

33 i.e. Franz Kohout, "Cyclical, Hegemonic, and Pluralistic Theories of International Relations: Some Comparative Reflections on War Causation," *International Political Science Review*, 2003, p. 53.□

itself was developed by economic historian Charles Kindleberger. He argued that the economic crisis of the late 1920s might only happen because Great Britain had ceased to be able while the US were not willing to be hegemon. Therefore the argument says that order in the international system could not be maintained without a dominant state that is able and willing to exert leadership. To achieve this it needs economic or technological pre dominance, expanding economy and willingness to provide stability for system.³⁴

What is important for this work is distinction between the notions of hegemon and empire as Britain is often described with both. However, both can exist separately, not having the same meaning. 16th century Spain and Portugal provides examples that it is possible to build empire without hegemony. The overwhelming American influence over the world immediately after the 2nd World War without territorial acquisitions proves that hegemony without empire is also possible.³⁵ For Doyle empire means control of both foreign and domestic policy while hegemony only is characterized through domination over foreign policy. In other words empire controls all aspects of life, internal and external policies while hegemon is in charge of only the latter.³⁶ Furthermore, few world-systems scientists suggest that hegemony can be seen as counter-imperialist project as the former does not usually encroach the sovereignty of other states and respect their territory.³⁷ Thus, what differs both, for Agnew, is the lack of hegemon's commitment to territorial dimension of power and its reliance on persuasion instead coercion. Thus, what hegemony usually means, is involvement of others in the exercise of power through convincing and cajoling them to do what hegemon wants.³⁸

2.2. Defining British hegemony.

At the beginning of the modern era five European states competed for control over the world. Portugal, Spain, the Netherlands, France, and Britain fought for the resources of the large spaces of Asia and New World.

34 C Kindleberger, "The World in Depression, 1929-1939," in *The World in Depression, 1929-1939* (University of California Press, 1986).□

35 John Agnew, *Hegemony: The New Shape of Global Power* (Temple University Press, 2005), p. 13.□

36 Michael W. Doyle, *Empires* (Cornell University Press, 1986), p. 40.□

37 Chase-Dunn, Taylor and Arrighi, p. 363.□

38 Agnew, *Hegemony: The New Shape of Global Power*, pp. 1–2,22.□

This fierce race for power eliminated many polities leaving only two states on stage – France and Britain. According to Gilpin Britain gained the edge over France due to accelerating pace of the Industrial Revolution and control of access to America and Asia which led to the clash between these two empires. As the competition between industrial Great Britain and mercantilistic Napoleonic France was won by the former the Pax Britannica emerged and peaked in 1849-80.³⁹ No matter how easy is this narrative to understand it seems to be too simplistic.

Most of the historians of early modern period would agree that the nexus of a number factors was responsible for the rise of Britain power. Few of these factors could be applied to all European states but some of them were British specific. Firstly, the monopolization and bureaucratization of military power were important for the emergence of the idea of modern national state. Secondly, the “Financial Revolution” created sophisticated system of financing wars, including new ways of imposing taxes.⁴⁰ Combined, these factors led to the emergence of the idea of so-called military fiscal state. However, Britain achieved leadership over the other great powers due to advantages impossible to find anywhere else. The most important was its financial sector - more effective, compared to other states – as it provided better financing for wars. It was featured by the creation of the first central bank, the Bank of England in 1694 and different structure of taxation, oriented to indirect than direct taxes.⁴¹ As early as in 1700s Britain was the leading maritime power in effect of overseas expansion (acquisitions of Bermuda (1613), St Kitts (1624), Barbados (1627), Nevis (1628) and Jamaica (1655)) while parliamentary union with Scotland in 1707 give new impetus for expansion of Empire.⁴² Hence, it is important to stress that certain aspects of British hegemony are to be found as early as in the 18th century, before the Napoleonic Wars and times of the 19th century full-scale Industrial Revolution.

Mann, who has recently finished the monumental four volumes long work “The Sources of Social

39 Robert Gilpin, *War and Change in World Politics* (Cambridge University Press, 1983) Gilpin, pp. 134–135.

40 Kennedy, pp. 73–77.

41 Kennedy, pp. 79–80; Patrick Karl O'Brien, “The Nature and Historical Evolution of an Exceptional Fiscal State and Its Possible Significance for the Precocious Commercialization and Industrialization of the British Economy from Cromwell to Nelson,” *The economic history review*, 2 (2011), 408–446 (pp. 428–430).□

42 Jeremy Black, *Great Powers and the Quest for Hegemony* (Routledge, 2007), pp. 71–74.

Power”, seems to be convincing in arguing for British dominance in the 19th century. Writing from historical sociologist's perspective he argues that the evidence for that is fourfold in character. Firstly, its domination on seas from 1817 to the 1890s, when the Royal Navy met Castlereagh's "two-power standard" is undisputed. Secondly, British industrial production between 1860 and 1880 also followed the Castlereagh's standard as it was greater than that of the next two Powers combined. However, it fell quickly at the beginning of the 20th century. Thirdly, British domination in industrial production per capita, which probably is more neutral indicator of industrial power, lasted longer, from 1830s until 1880s. Fourthly, in 1860s Britain produced half of the world's iron, coal and lignite. It also supplied half of the half the world's supply of raw cotton. Thus, it is hard not to agree with Mann who argues that Britain was second-level hegemon as the global hegemon was the West as a whole.⁴³

Historian Paul Kennedy wrote well-known book entitled *The Rise and Fall of the Great Powers: Economic Change and Military Conflict From 1500 to 2000* which explores the politics and economics of the Great Powers from 1500 to 1980 and reasons for their decline. The book also provides interesting statistics about British industrial production. Two-thirds of Europe's industrial growth of output was produced on the Isles and their global share of industrial production rose from 1,9% to 9,5% between 1760 and 1830. The indicator rose even higher – to 19,9% in the subsequent thirty years. In other words a state inhabited by 2% of world population and 10% of Europe's population pushed its capacity in industrial production up to the level of 40-45% world production and 55-60% of European industrial production. While these numbers seem to indisputably prove British hegemony Kennedy questions it. Firstly, he points out that until 1850 agricultural sector was the basis for creation of GNP all over the world. Hence, large-scale entities like Russia or China were privileged. Secondly, he argues, Britain's military resources could not be mobilized quickly. The laissez-faire ideology, which promoted “more productive” allocation toward economy than in war, is to be blamed for that. Moreover, military expenditures were kept at very low level at this time, 2-3% of GNP. Government's expenditures took less than

⁴³ Mann, pp. 264–266.□

10%, levels impossible to imagine in 18th or 20th centuries.⁴⁴

Table 9.4 Britain's decline in naval power and leading-sector production

	<i>Naval power share</i>	<i>Leading sector share</i>
1780		0.292
1786	0.360	
1790		0.455
1796	0.363	
1800		0.534
1806	0.419	
1810		0.603
1816	0.660	
1820		0.549
1826	0.582	
1830		0.643
1836	0.482	
1840		0.583
1846	0.493	
1850		0.546
1856	0.505	
1860		0.500
1866	0.475	
1870		0.519
1876	0.434	
1880		0.430
1886	0.479	
1890		0.333
1896	0.467	
1900		0.245
1906	0.392	
1910		0.146
1916	0.424	
1920		0.100
1926	0.336	
1930		0.082
1936	0.273	
1940		0.075
1945	0.350	
1950		0.093
1960		0.087
1970		0.070
1980		0.039

Sources: The naval capability shares are taken from Modelski and Thompson (1988); the leading sector shares are taken from Thompson (1988)

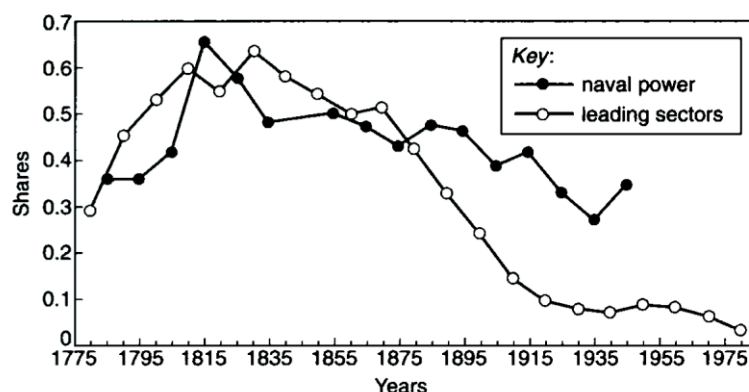


Figure 9.1 British relative decline

Source: Thompson, 2002, pp. 182, 184

In the field of international relations few scholars have made attempts to present British power in quantitative terms. Yet, from this perspective the image of British hegemony is also vague. Its peak of naval power share and leading sector share occurred between the times of the Napoleonic wars and 1830s and never reached the same levels again.⁴⁵ If it is so it brings to life the question whether British hegemony was an industrial one at

⁴⁴ Kennedy, pp. 151–153.□

⁴⁵ William R Thompson, *The Emergence of the Global Political Economy* (Routledge, 2002), p. 182.□

all. This piece of data suggests that it was in decline in the era of steam and electricity. Moreover, as the decline accelerated after 1875 it makes even more plausible the assumption that industrialization of the world made Britain weaker.

Furthermore, the character of power relations between states changed in the course of the 19th century. The Concert of Powers was established on territorial not military balance of power but changes in military technology led to the exposition of military strength as primary measure of a state's influence. Territory was replaced with industrial dynamics in measuring power.⁴⁶ For some time, Britain was able to counterbalance and out compete Russia's and China's vast spaces providing people and land with effective navy. However, the decline of British power parallel to the spread of industrial technologies corroborates the hypothesis that succession of pre-modern technology with modern – or at least industrialization of warfare – weakened British dominance.

R. Lebow, when trying to asses validity of power transition theories, proposed an indicator of state power made by multiplying of a country's GDP by its total population. He reasonably explains his choice arguing that in Malthusian reality both - population and GDP - were closely related. What is to be seen from his calculations is that Britain was not hegemon in any period in history. Spanish domination in the post-Westphalia period was replaced by Russia in the early the 18th century, which was surpassed by the United States in 1890s.⁴⁷ To a certain extent it makes valid the argument that industrialization did not influence British power that much as it is used to think. If it had been the case it would have raised GDP to a level high enough to appear on the figure.

⁴⁶ John Agnew, *Mastering Space: Hegemony, Territory and International Political Economy* (Routledge, 1995), p. 30.□

⁴⁷ Lebow and Valentino.□

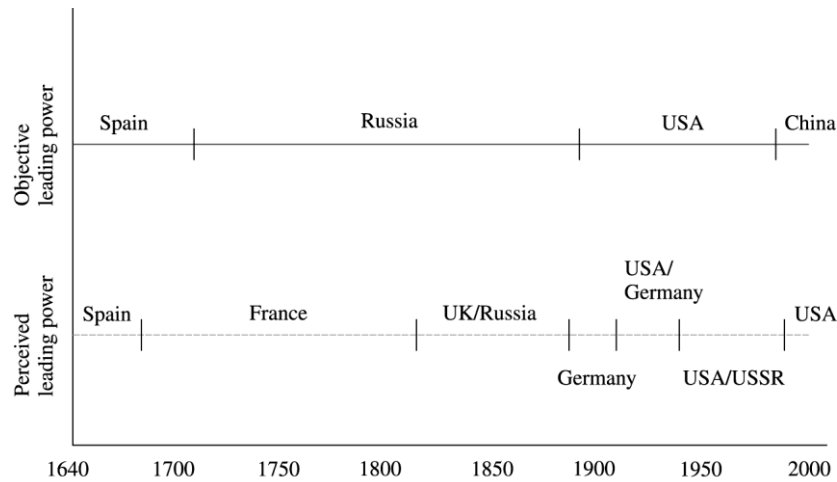
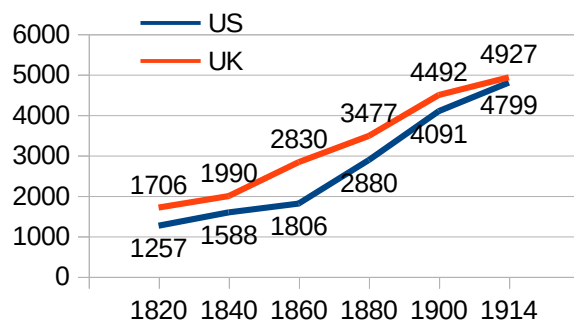


Figure 5 “Objective” and perceived leading powers
Source: Lebow & Valentino, 2009, p. 407

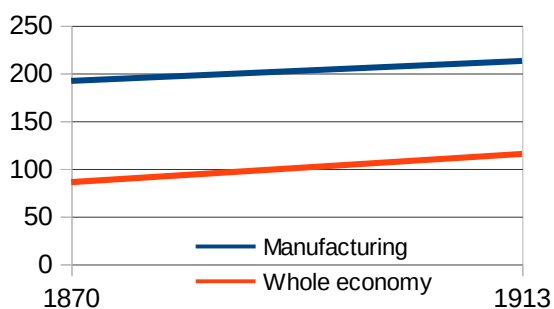
Even in 1870's, when industrialization was well under way in Britain, it is not easy to find its superiority over other societies. In relation to British the US GDP was 108% and Russian was 90% at this time. British military expenditures were more than 30% higher than American but lower than Russian (120% of British military expenditures) and French (113% of British military expenditures). Finally, what can be found in the Correlates of War (COW) composite index seems to argue in favour of the argument of British domination. In 1872 French score was 60% of British, German and American 50% respectively. Yet, even the last score can be strongly skewed because of the index's preference toward industrial sub-components (levels of iron production and coal consumption) and British early industrialization.⁴⁸

⁴⁸ WC Wohlforth, “The Stability of a Unipolar World,” *International security*, 24 (1999), pp. 12–13.□

On the left side: GDP per capita, in 1990 dollars, based on (Maddison, 2006; 437,439 465-6); On the right side: Comparative US/UK output per employee in manufacturing and the whole economy, (UK=100) (Broadberry, 1997; p.



66)



conomy was the strongest side of Britain but its economic
had advantage over the US in terms of GDP per capita for
et, this domination was not substantial and the US started
14, as shown on the figure above. While GDP British per

capita rose from 1,706\$ in 1820 to 4,927\$ in 1913, American average income grew from 1,257\$ in 1820 to 4,799\$ in 1913.⁴⁹ The basis for British advantage in productivity was rooted in early structural change, not in extraordinary inventive and productive manufacturing sector. The Industrial Revolution allowed British, as the first society in the world, to free labour to work in factories. Hence, British superiority was based on the industrial sector where value added per employee is higher than in agriculture. As Broadberry argues “this lack of a low productivity agricultural sector is very important in explaining Britain's overall productivity leadership during the nineteenth century, which we have seen was not due to productivity leadership in Britain's manufacturing industry.” As early as in 1870 American productivity in manufacturing was almost twice higher than British (192.0) when overall productivity was very near to British (85.9). In 1913 American productivity in manufacturing was more than two times higher (212.9) and even overall productivity was also higher compared to Britain (115.5).⁵⁰

49 Angus Maddison, *The World Economy* (OECD, 2006), i, pp. 437,439, 465–6.□

50 Stephen N. Broadberry, *The Productivity Race: British Manufacturing in International Perspective, 1850-1990* (Cambridge University Press, 1997), p. 65,66.□

Therefore it is reasonable to argue that if British domination existed it was rather latent in kind. The Napoleonic Wars brought to stage three potential hegemons: Britain, Russia and France but British dominance was not easy to find until its victory in the Crimean War, 1856. From this perspective the 1815-1856 period was featured by triple leadership. Wohlforth makes interesting point: “the nineteenth century was not a “Pax Britannica.” From 1815 to 1853, it was a Pax Britannica et Russica; from 1853 to 1871, it was not a pax of any kind; and from 1871 to 1914, it was a Pax Britannica et Germanica”.⁵¹ What is therefore suggested is that there was group, cooperative hegemony of two or more European states. The hypothesis is partially supported by Clark who argues that Britain remained the only power in economic sphere but, in terms of security, it relied on collective hegemony of the Concert of Powers. Moreover, when compared to the US, Britain was far more 'benevolent' hegemon. Cooperation with it was not encouraged nor enforced by strategic competition of any kind as it had no competitors at this time.⁵²

Interestingly, even if they doubt in British hegemony, both - Mann and Kennedy - admit that in certain areas Britain's predominance was periodically overwhelming. Mann calls it “specialized British hegemonies” - sectoral areas of dominance and global naval dominance achieved through diplomatic arrangements.⁵³ Kennedy identified three realms of British dominance where no serious rivals remained. In terms of actual fighting power the Royal Navy could be as powerful as the next three or four navies altogether. British domination came from the lack of the competition when it comes to expansion of colonial empire until 1880 and financial superiority that was product and – in the same time - fuel for British development.⁵⁴

Finally, it is hard to find strong evidence for traditional narrative claiming indisputable British hegemony in the 19th century. According to many scholars presented in this section, Britain lacked important characteristics of a hegemon. Its military dominance was only naval in character so Britain was unable to dominate vast stretches

⁵¹ Wohlforth, pp. 20–21,39.

⁵² Clark

⁵³ Michael Mann, *The Sources of Social Power, Vol. 2. The Rise of Classes and Nation States* (Cambridge: Cambridge University Press, 1993), pp. 264–266.□

⁵⁴ Kennedy, pp. 154–158.□

of land. Its economic edge did not provide enough wealth to counterbalance such competitors as Russia or US for long period which, even if based on agriculture, were able to produce higher GDP. In political terms, Britain lacked will to engage in European – at that time political centre of the world – affairs as British preferred “splendid isolation” and overseas expansion. All of these arguments indicate that British paid close attention to capabilities they possessed and thought in strategic way, trying to avoid “imperial overstretch”. In the same time limitations imposed by the size of Isles seem to be clear. Hence, British position, constrained and defined to a reasonable extent by geography, is to be described as merely “dominance”, yet not “hegemony”.

3) Energy and global hegemonic wars. 1763 – 1830s

3.1.1. The role of the wind-powered and the beginnings of steam-powered Royal Navy.

The first scholar who attributed development of the British Empire in the years 1660-1783 to correct use of sea power and stressed the role of naval power for power of state was one of the fathers of geopolitics, A. Mahan. Writing in 1890, at the dusk of wind-powered ships, he perceived commerce and fisheries as the basis of sea power while military navy is to be built up on it.⁵⁵ “In (...) three things, production, with the necessity of exchanging products, shipping, whereby the exchange is carried on, and colonies which facilitate and enlarge the operations of shipping and tend to protect it by multiplying points of safety — is to be found the key to much of the history as well as of the policy, of nations bordering upon the sea.”⁵⁶ Hence, the main goal of the Royal Navy was to defend commercial ships and make maritime trade roads safe.

If for Tudors navy was merely a defence squadron in the second half of the 17th century Royal Navy became a mean of a national commercial policy. The Navigation Acts (1651, 1662) and the three naval wars against the Dutch (1652–4, 1665–6, 1672–4) marked change in state's recognition of sea power importance. Navy increased in size and quality of staff improved as well. “Between 1646 and 1659 217 vessels were added to the fleet (...) officers were required to be examined, a statutory code of naval discipline was introduced, and successive Fighting Instructions advocated line-of-battle tactics to maximize naval fire-power.” Yet, Dutch still dominated global economy and it was only after the Glorious Revolution when British were able to reach for dominance on seas.⁵⁷

Brewer suggests that British supremacy is to be traced as early as to the Treaty of Utrecht (1713). Signed by the belligerents in the War of the Spanish Succession it raised to power Britain and France and marked new stage of rivalry between them. At this time, as he argues, British had no other competitors on seas that was

55 A. T. Mahan, *The Influence of Sea Power Upon History 1660-1783* (Boston: Little, Brown, and Company, 1890), p. 70.□

56 Mahan, p. 26.

57 John Brewer, *The Sinews of Power: War and the English State, 1688–1783*, 1989, p. 9.

their greatest advantage over French. There were few reasons for that. French navy was destroyed by the Anglo-Dutch fleet at La Hogue in 1692. The Spanish fleet, the only one that posed any threat in 1714, lost the decisive battle with Royal Navy in 1718 at Cape Passaro. In the same time United Provinces cut its naval expenditure. While these factors left British as military hegemony on seas the domination in global trade still lied in the hands of Dutch.⁵⁸ The Treaty of Utrecht was a landmark in rise of British as great power. Spain was severely hurt by this process. Asiento, the monopoly license to import into Spanish America was granted to British for 30 years who also acquired Gibraltar.⁵⁹

However, the turning point was the Seven Years' War. It brought decisive triumph to Britain as all the wars since 1689 gave them only small victories. Especially, won battle at Quiberon Bay in 1759 ended any French hopes to challenge British on seas.⁶⁰ The effect was explosive growth of colonial re-exports. The Seven Years War, which ended in 1763, is important for the quest for leadership as "Britain had shown that a nation that monopolized the elements of sea power – dominant regional battle-fleets, a large and heterogeneous maritime economy, an effective strategy against enemy commerce and substantial amphibious forces—could have a major impact on the powers of western Europe." But one should not be misled with this statement as the numbers suggest that British dominance was not overwhelming. For example, Britain did not have numerical superiority from 1765 until 1800. While in 1760 it possessed 38% of world tonnage (compare to 30% of France and Spain combined) in 1775 the former possessed 35% of the world share compared to 30% of Britain.⁶¹

Hence, the sources of the British monopoly must be multiple, quantitative as well as qualitative. Indeed, there were improvements in the management of the navy that gave further advantage to the British. Long-range plans to establish dockyards, neglected during the 7 Years War, were made. "Anti-scorbutics were tested, pumps, blocks, tackles, timber preservation and yarn tarring machines were tried." The Earl of Sandwich, the First Lord

⁵⁸ Brewer, pp. 139–140.□

⁵⁹ Ronald Findlay and KH O'Rourke, *Power and Plenty: Trade, War, and the World Economy in the Second Millennium* (Princeton University Press, 2007), p. 251.

⁶⁰ Findlay and O'Rourke, p. 254,255.□

⁶¹ R Harding, *Seapower and Naval Warfare, 1650-1830* (UCL Press, 2001)Harding, p. 219,220.□

of the Admiralty, conducted several annual inspections of the dockyards in 1770s. The quality of sailors and uncommon tactics gave support to the British in the hard times of 1780-1781. Moreover, this period marks cooperation that could be described as public-private partnership as public dockyards were supported by private one. Even if the Navy disliked to use their help they were far more integrated into the process of construction due to economic reasons. The solution was so effective that Spanish or French tried to copy it. Interestingly, British perceived their own ships as inferior to French either. Therefore, as Harding argues, “the critical difference lay in the handling of the ship by experienced crews.”⁶²

However, no one is invincible and the British were so. They lost the global war began by the American Revolution in 1776. The Treaty of Versailles (signed on the 3rd of September, 1783) not only recognized the independence of the United States but also gave territorial acquisitions to France. This was partially responsible for the fact that, at this point in time, European international system was more evenly balanced than at any time since 1697. What could change the balance of power was technological advancement and British seemed to leader in this field. In 1779 new, powerful cannon was introduced by the Royal Navy. Manoeuvring characteristics of the British ships rose due to the copper sheathing which was a mean of protect from marine growth and fouling that helped them to navigate smoothly.⁶³

The British maritime power was strengthened between 1793 and 1815, giving them strong foundations to influence global system until 20th century. Changes in tactics, especially departure from the line of battle, enforced changes in ship design, hence technological progress. The Royal Navy got back to the large three-decks ships, equipped with 100 guns or more. These new battleships were faster compared to previously built three-decks vessels and vulnerable parts, stern and stem, were strengthened.⁶⁴ A new system of framing ships diagonally and new bow and stern structures were introduced that increased structural strength and reduced

⁶² Harding, chap. 9.□

⁶³ Harding, chap. 9.□

⁶⁴ Harding, pp. 257–260.□

vulnerability to raking fire.⁶⁵ Overall, as a number of conflicts showed, the British navy's capacity for mobilization of resources outstripped its rivals: France retreated in 1787, Spain in 1790. Gains in Caribbean area illustrated the main advantage of sea power in the end of the 18th century – the ability to concentrate forces at the weakest point of enemy that led to local victory. Yet, the Royal Navy “seemed incapable of delivering anything militarily or diplomatically significant. Seapower was only important if it could influence events ashore and, apart from the West and East Indies, British seapower had not produced results ashore.”⁶⁶ For example, after crushing the French navy on the 1st of August, 1798 Nelson sailed to Naples to encourage its inhabitants for uprising against French who occupied Rome. While the initiative was successful at the beginning it finally fell in the face of superior French land forces.⁶⁷ But even this underwent change. In early 1800s the royal Navy developed ability to attack from the sea large population centres as it was in the cases of Buenos Aires (1806), Copenhagen (1807), Washington (1814) and Algiers (1816). In 1810 British domination was indisputable. The Navy was perfectly integrated into British state, its merchants and army, supporting them, being supported and united in enriching the country. In 1815 Britain's position was completely unchallenged. The only naval power whose naval capability increased after 1815 was the overseas United States as the European revival in naval building did not occur until the 1840s.⁶⁸

Yet, achieved dominance did not mean that the Navy was reluctant to introduce technological novelties as it was always important factor in quest for power. First attempts to build a steamer were made in 1815 in order to explore Africa's river Congo but its engines turned out to be too heavy. In 1819 steam-powered vessels were used to tow sailing ships in and out of harbour and between ports. The initial success of the Post Office in operating the Holyhead–Dublin line inspired the Navy to try once again. *Comet* was build in 1822 followed by *Lightning* in 1823. The latter was used afterwards to support ships on operational deployments and joined by *Meteor* and *Echo* no later than in 1827. Between 1828 and 1831 all three vessels achieved HMS status. In 1829

⁶⁵ E Grove, *The Royal Navy Since 1815: a New Short History* (Palgrave Macmillan, 2005), p. 2.□

⁶⁶ Harding, pp. 266–267, 269.□

⁶⁷ Harding, p. 273.□

⁶⁸ Harding, chap. 10.□

the Navy not only had 8 paddle steamers in possession but also the much larger steam warship was under construction.⁶⁹

Above presented arguments are partially supported by quantitative research. The numbers tell us that Britain possessed 50 percent share of the naval capabilities in the global system in two periods of time – 1810–34 and 1855–59. Between 1710–74 and 1805–1904 it possessed more than 40% for the years. This piece of data implies two things. Firstly, Britain had in control as many naval capabilities as all other great powers combined for the relatively short periods. In other words, while being a great power it did not have to be the global hegemon. Secondly, majority of this dominance was before industrialization of war i.e. 1810–34. It suggests that coal was not important factor in achieving maritime dominance.⁷⁰ It seems to be clear it was possible for Britain to get substantial advantage in the 18th century over other states without recourse to new sources of energy. In other words even wind-powered the British navy was able to dominate global seas.

Hence, other factors should be taken into account. One of the most important was more than strong commitment of British government toward sustained funding of maritime capabilities. “While in England the importance of naval power was a virtually incontestable shibboleth, in both France and the United Provinces the navy was something of a political football, likely to be kicked by its adversaries out of play.”⁷¹ Continued investment was supported by British prime ministers and even if few of them tried to stop funding of warfare, the Navy was immune.⁷² To extract more money for wars from society, taxation system evolved and improved. Hence, the next section investigates new technologies in British economy which helped to raise productivity and income – and their possible connections to energy.

3.1.2. The role of the Industrial Revolution for British financial dominance

It has been argued for years that improvements in taxation system and the creation of the first central

⁶⁹ Grove, p. 4.□

⁷⁰ JS Levy and WR Thompson, “Balancing on Land and at Sea: Do States Ally Against the Leading Global Power?,” *International Security*, 35 (2010), 7–43 (p. 27).□

⁷¹ Brewer, p. 26.□

⁷² Harding, pp. 234–235.□

bank in 1694 combined laid the financial basis for the rise of the British Empire. Taxes were collected indirectly which made them easier and more efficient to collect compared to France where large groups of tax farmers were employed to collect taxes directly.⁷³ The very recent study corroborates these findings. It can be summarized as follows: “the evolution towards a fiscal constitution rebalanced towards indirect taxation began earlier in the seventeenth century, but received strong impetus from the Civil War and Interregnum. It came fully on stream over the century after 1713 when around three-quarters of all tax revenues received by successive British governments took the form of indirect taxes.” Most of these taxes were levied on the domestic production of goods and services.⁷⁴

Hence a question should be posed whether there was connection between coal-powered machines producing indirectly taxed goods and rising income of the British state. In the late 18th and 19th century economic growth on the Isles was truly impressive, reaching around 1,8% for the years 1780 – 1811, accelerating later to 2,8% in 1811-21 and 3,6% in 1821-1831.⁷⁵ The application of energy to production processes was under way. While total output of all coal mines could even have doubled between 1790 and 1815 real prices of the fuel in Britain were falling, except of London. In the same time taxes imposed on coal export could reach 70% which effectively stopped any attempts for the diffusion of British way of energy use as coal was far more expensive elsewhere. Moreover, rapid exploitation of the new source of energy in heat intensive industries put British owners and managers in the mining industry into trajectory that guaranteed long-term investment and commitments.⁷⁶ These economic and social factors undoubtedly suggest long-standing relationship between coal and economy, but how to connect them to taxation system?

To run British war machine more than 20 new taxes were imposed in times of the wars against

73 Brewer, p. xiii; Kennedy, pp. 79–80.□

74 P O'Brien, “The Nature and Historical Evolution of an Exceptional Fiscal State and Its Possible Significance for the Precocious Commercialization and Industrialization of the British,” *The economic history review*, 2 (2011), 408–446 (p. 429).□

75 Patrick Karl O'Brien, “The Contributions of Warfare with Revolutionary and Napoleonic France to the Consolidation and Progress of the British Industrial Revolution”, *LSE Working Papers No. 150/11*, 2011, p. 45.□

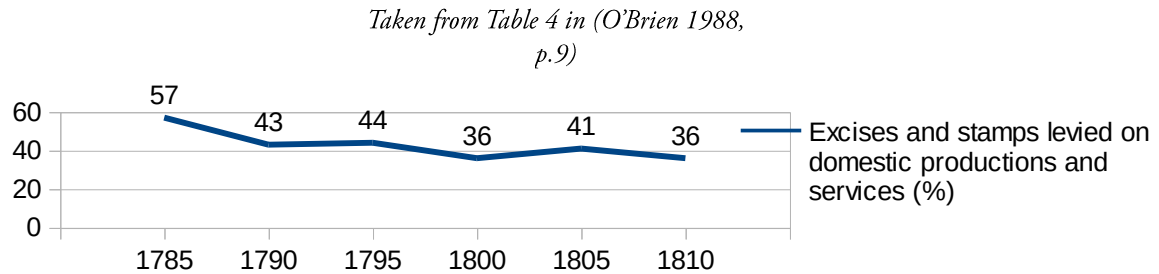
76 Patrick Karl O'Brien, “The Contributions of Warfare with Revolutionary and Napoleonic France to the Consolidation and Progress of the British Industrial Revolution”, pp. 53–54.□

Revolutionary and Napoleonic France. Ships' hulls and materials, watches and clocks were taxed but their contribution was very small. There were also attempts to impose excises on iron. Obviously, few sectors, related to the industrialization process continued to grow as the whole British economy was growing. Additional capacity was added in the armaments, iron, food-processing, shipbuilding and textile industries. Yet, increments that came from these developments were not high enough to finance wars. Thus, we cannot attribute increased income to growing quantities of goods produced thanks to the application of the coal-powered machines. O'Brien also argues that the Industrial Revolution had limited impact on extending tax base and most of the increments should be assigned to institutional development that can be traced as far to the past as to the Interregnum (1642–59).

However, goods produced in industrial processes could have indirect impact on economic growth, hence British financial power. As production was rising the volume of goods and services complementary with previously taxed goods increased. Hence, taxation base as a whole was rising. Additionally, economic growth yielded higher income for the British population which, in consequence, meant more money spent on taxed goods. Therefore, both sides – supply and demand – for industrial goods was rising. Parliament opposed imposition of taxes on coal-dependent sectors which were growing quickly and sent high share of output abroad i.e. textiles, metallurgical products and pottery. Apparently, inputs for these processes (iron and other ores, coal sold outside London and British-grown timber) and transport modes (i.e. canals and turnpikes) were so important that remained untaxed. “However, extend taxation to include raw cotton, indigo, tallow and farm horses, and the exchequer derived direct benefit from investment in industry and transport through a range of taxes levied on bricks and other construction materials.” Therefore, rapidly growing coal-dependent industrial sectors influenced British finances indirectly by creating demand for already taxed intermediate goods and raw materials; not by directly imposed taxes.⁷⁷

⁷⁷ Patrick Karl O'Brien, “The Triumph and Denouement of the British Fiscal State: Taxation for the Wars Against Revolutionary and Napoleonic France, 1793–1815,” in *The Fiscal-Military State in Eighteenth-Century Europe. Essays in honour of P.G.M. Dickson*, ed. by C. Storrs (Ashgate, 2009).

Even close look on statistics gives supporting outcome. On one hand taxes collected from excises and stamps – which includes all taxes imposed on domestically produced goods and services – were falling at the breakthrough of the 18th and the 19th century.⁷⁸



On the other hand, revenues from the consumption of industrial goods were rising in constant prices – from 30,7 million pounds to 63,7 million in 1810. Yet, their share fluctuated and never exceeded 21% of annual

tax receipt before 1810.⁷⁹

This leads to the final conclusion that goods produced in steam-powered factories, even if they could be more easily taxed in indirect way, were not very important for the British taxation system. Therefore, they cannot be regarded as the source of British financial superiority. Hence, coal cannot be considered as foundation for dominance either.

⁷⁸ Patrick Karl O'Brien, "The Political Economy of British Taxation, 1660 - 1815," *The Economic History Review*, 41 (1988), 1–32, p. 9.

⁷⁹ Patrick Karl O'Brien, "The Political Economy of British Taxation, 1660 - 1815", p. 15.□

4) Energy, quest for hegemony and colonial expansion. 1830s – 1914.

4.1.1. The role of the British fleets.

Water was always important in humanity in many aspects. When it comes to economics water transport was always cheaper than that over land. In terms of factors important for the global quest for power, history of the last 500 years shows that only maritime powers were able to dominate international realm economically as well as politically. The role of British fleets since 1830s can be therefore divided roughly into three aspects. Firstly, merchant fleet was one of the most important components of economic power of the Empire, providing communication and steady inflow of resources to British economy. Secondly, the Royal Navy served as protection for economic ventures and a mean for sustaining military-political domination. Thirdly, fleets were of critical importance for colonial expansion which gave access to new resources, markets and helped the Empire to broaden tax base. In other words it helped to multiply and diversify sources of income. This section looks for connections between these three aspects of British power and energy.

4.1.1.1 *The British merchant fleet*

The spread of new technology – steam engine - was not that brief as one may be tempted to think. According to Allen the general mechanization of British industry did not begin until 1845, when new patent for improvement of steam engine was issued to William McNaught. Since then the pace of diffusion of the new technology speeded up. In 1855 Britain was connected with France and Low Countries by steam-powered trade. In 1865 it reached the Easter Mediterranean placed 3,000 miles away the Isles. By early 1870s both ends of Atlantic were connected by steam. Distance increased to 5,000 miles by late 1870s and even New Orlean was connected. During 1880s sail was displaced on the lines to Asia. To make these changes possible cost of shipping by steam had to drop below that of by sail.⁸⁰

Two reasons were mainly responsible for British economic supremacy on seas during steam era. Firstly,

⁸⁰ Allen, pp. 172, 178.□

economic incentives for investment in large merchant fleet were very strong. Large-scale production of ships and engines was helpful to keep the costs down while government's subsidies protected large share of the fleet from market uncertainties. British control of submarine cables gave informational edge over its competitors. Secondly, energy played the role. In the era of steamships Britain had the most and the cheapest coal. It not only made her independent of external sources but also provided additional, important, source of income in the industrializing world. In 1911 coal constituted 90% of export (by weight). It made British trade more balanced as its competitors did not have too much to send overseas. British were also the first who started to exploit energy resources in other parts of the world. "Coal from Bengal was being used in steamers in the 1830s, from Borneo in the 1840s, and from Natal in the 1860s. Though not as good as Welsh coal, they gave Britain a near-monopoly of the world's steamer coal supplies."⁸¹

Initially, during the 1830s and 1840s, use steamships was expensive and limited only to the issues where speed mattered i.e. carrying wealthy people of transporting mails. "To sail from Bombay to Aden in 1830, the Hugh Lindsay had to fill its hold and cabins and pile its decks with coal, barely leaving room for the crew and the mail. Ten years later the first Cunard liner, the Britannia, needed 640 tons of coal to cross the Atlantic, leaving only 225 tons of cargo capacity" Moreover, refuelling opportunities – coal stations - were limited as most of the world's coal came from Britain. Therefore, even in the 1850s steam-powered freighters were used in the Mediterranean and the Atlantic regions only for expensive cargoes. Four innovations helped to lower costs and to improve position of steamships against sailing ships. Screw-propeller, the iron hull, the surface condenser and compound engine were introduced in 1850s and 1860s. Screw propellers eliminated inefficient and vulnerable in high seas paddle wheels. Ships with iron hulls were 30-40% smaller in terms of weight compared to wooden ones. In the same time their capacity was 15% higher. The surface condenser, which allowed to use of recycled distilled water, helped to devoid salt water. It was important development inasmuch as salt water corroded machinery propelling ships. Lastly, compound engine made it possible to use remaining pressure that steam still contained after leaving one cylinder to another. The final effect was impressive improvement in fuel efficiency.

81 Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850–1940*, pp. 42–45.□

While "the earliest steamers needed 4 kilograms of coal per hour for every indicated horsepower. By the 1850s coal consumption had fallen to 2 kilograms and by the mid-1860s, to 1.6 kilograms."⁸²

Since the opening of the Suez Canal in 1869 engineers devoted time for improvement of two part - hulls and engines. Initially, the uneven quality of the Besemmer process had made it impossible to use steel but it change in 1870s with perfection of the Siemens-Martin process. In early 1880s steel of proper quality became cheap enough to be used for construction of merchant ships. Steel not only helped to save the weight but also it was more resistant to corrosion. Because of these advantages steel was applied to engines with aim to reduce fuel consumption by raising pressure. Pressures rose to "6 kilograms per square centimeter in the late 1870s, then to 9 kilograms in the early 1880s, to 12 in the 1890s, and finally to 14 by the turn of the century." Increase in pressure allowed to add third cylinder to engine. The combination of steel hull with triple expansion engine led to the greater fuel efficiency throughout the merchant fleet. "Average fuel consumption per horse-power per hour, which had been 2,300 grams of coal in 1855, dropped to 1,600 in 1865, to 800 in 1881, and to 700 in 1891." In the same time price of coal was also declining from 12 shillings, 6 pence per ton in 1867-77 to 9 shillings per ton in 1878-87.⁸³

Technological progress and abundant coal deposits allowed British to get the largest share in the distribution of freight activity in early 20th century. According to list of the major shipping companies published in 1911 by maritime expert Georges Michon British had 57% of the ships and 56% of the tonnage, the Germans had 25% and 28%, the French 12% and 11%, and the Japanese 6% and 5% respectively. The first British steamship line working in East was, founded in 1834, the Peninsular Steam Navigation Company (later renamed into Peninsular & Oriental). The line grew and became the biggest shipping company due to services contracted by British government. However, as it was in the case of the British India Steam Navigation Company, many shipping companies were able to begin commercial activity with only small subsidies and later grew without any external help. As "British firms led the field by introducing the most technically advanced ships (...) Alfred and

82 Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850–1940*, pp. 23–25.

83 Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850–1940*, pp. 27–30.

Philip Holt started the Ocean Steam Ship Company, or Blue Funnel Line, in 1865 by sending compound-engined steamers between China and Britain at record speeds." The line not only took trade with China away from clippers but it also got large share of trades of Malaya and Netherlands East Indies. British were also first who applied new technology to improve trade with Africa. The first line was Macgregor Laird's African Steam Ship Company, founded in 1852 with governmental contract to deliver mail to Lagos and the Bight of Benin. It was joined by the British and African Steam Navigation Company. When they were merged in 1890 formed the Elder Dempster Lines, the line that dominated the trade of British West Africa.⁸⁴

4.1.1.2 The Royal Navy and coal

Being in order of the most powerful navy in the world her admirals were conscious of the technological revolution which was under way since the late 18th century. With 15 steamers completed between 1830 and 1837 the overall number of steam-powered warship increased to 24. There were as many, if not more, steamers in commission than ships of the line. Moreover, new steamer HMS *Gorgon*, over a half bigger than any other steam-powered vessel in commission at this time, was under construction. In 1837 Royal Navy acquired 34 packet steamers from Post Office due to complaints on the quality of service.⁸⁵

The 1840s was a decade which brought further changes. While "the Royal Navy's first iron seagoing warships, the paddle sloop *Trident* and paddle frigate *Birkenhead*, were launched in 1845" combat experience suggested that it was too early for large-scale adoption of steamers. The argument behind was the fact that during the intervention in Uruguay an iron ship, HMS *Lizard* was riddled for two hours by the Argentine guns. Thus, when Whigs came to power in 1846 iron as a primary construction material was abandoned. Introduction of screw-propeller, demonstrated to the Admiralty in 1837, had more immediate impact. Without this important development steam engines would be nothing more than auxiliary to the sailing ships. The problem were paddle boxes, mounted on the both sides of ships. They not only interfered with attempts to increase fire-power but also remained vulnerable and could be easily destroyed. Thus, when tensions with France increased in 1844, screw-

84 Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850–1940*, pp. 39–42.□

85 Grove, pp. 12–13.□

propellers were built into 4 iron frigates under construction which were an attempt to combine limited auxiliary power with maximum fighting power.⁸⁶

The process of introducing new technologies was slow but inexorable. In 1846 a special squadron was formed of about 20 ships. It consisted of steamers that were in equal proportion to sailing ships. As international tensions rose the balanced steam and sail fleet setup became standard for main fleet deployments. “In the Mediterranean in 1847 were nine sailing ships of the line, each paired with a steamer; the latter were to tow the sailing ships when necessary as well as use their mobility to support more heavily armed liners in action.” Sailing ships based in Portugal, East Asia or in home waters – all were paired with steamers. Despite progress British competitors, French, were those who built the first steam-powered battleship - a 90-gun *Le Napoléon* in 1850. The British response was HMS *James Watt*, laid down in 1850 and launched in 1853. “Work on sailing ships was stopped in 1849 and conversion of ships laid down as sailing vessels began (...)” as usefulness of screw-propeller was finally proved. Only the problems with steady supply of coal and unreliability of machinery prevented steamers from relying on screws as primary power.⁸⁷

Technology and science made direct impact for the first time during the Crimean War (declared on 27 March 1854) which, because of that is used to be called the first industrial war. During the war steamers were used by British and French on large-scale. The first attack was launched against Odessa which was by task force largely made up of paddle frigates. In the course of operations undertaken in May 1854 on the eastern shores of the Black Sea, included steamers, British lost the paddle steamship *Tiger* after it went aground off. During the attack on Sevastopol “five steamers, including the remaining gun vessel, *Lynx*, acted as a mobile inshore bombardment force while the other steamers brought the sailing ships into position, some lashed to the latter’s disengaged port sides”.⁸⁸ At the same time British decided to project force in the Baltic sea area to put more pressure on Russia. Steamers played various roles in this endeavour either. While the early paddle steamers

86 Grove, pp. 23–25.□

87 Grove, pp. 23–26.□

88 Grove, pp. 29–31.□

Lightning and *Alban* served as navigational support, the pioneer first-class paddle frigate *Penelope* was used for reconnaissance. In January 1855 the Crimean fleet was strengthened by two more steam liners, *Princess Royal* and *St Jean d'Acre*, to add to *Royal Albert*, *Agamemnon*, *Hannibal* and *Algiers*. Lightly armed paddle frigates were replaced by the more powerful ones. In February 1855 steamers were used to block Russian ports and the Straits of Kerch. The use of steam-powered warships helped the Western allies to achieve overwhelming advantage over Russia. Fossil fuels provided reach and logistics impossible to get with wind. "In the final days of the siege the allies were able, in a single day, to fire as many as 52,000 cannon-balls against Sevastopol's fortifications, whereas the Russians had to ration their guns for lack of sufficient powder and shot."⁸⁹ Russia was the first but not the last state which experienced that industrial technology became critical factor in warfare. "The Royal Navy could now project effective and destructive power from the sea when and where it wished. No potential enemy coast or naval base – French, Russian or American – was safe."⁹⁰ Consequences of technological progress became noticeable on world scale.

According to Grove ships built at the breakthrough of 1850s and 1860s expressed British industrial superiority. HMS *Warrior*, laid down on 25 May 1859, had not only superior armour and but also guns could fire solid, explosive and incendiary shots. The ship was undestroyable by any combination of wooden ships. The end of the construction of further wooden ships of the line was voted in the House of Commons in April 1861. The modernization of the Navy was well on the way. By the mid-1860s almost the entire operational fleet was coal powered. In 1867-8 the last wooden capital ships were withdrawn from service as 6 new ironclads were laid down. Ships built at the beginning of 1870s had range between 4700 and 5700 miles at 10 knots speed, impossible to be achieved without fossil fuels. Yet, speed of ships was still limited to no more than 13 knots in case of small and 15 knots for bigger ships. The revolutionary step was to make all-steel ships. The first of them, *Iris* and *Mercury*, were laid down in 1875 and 1876 and turned out to be the fastest ships of their day, making 18.57 knots on trials. As they set new standards in ship design up, they can truly be called the first modern

89 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 230.□

90 Grove, pp. 29–39.□

warships. Ships were also featured by newly developed technologies that required energy from fossil fuels. One of them was installation of electric light on newly built or modernized vessels.⁹¹ A boat builder Alfred Yarrow constructed in 1880s the first high-pressure water-tube boiler that allowed to build first ships ever in “destroyer” class which attained speed over 26 knots.⁹² Simultaneously, efficiency of ships was still rising. New armour-plated turret ships, *Nile* and *Trafalgar*, could operate in range of 6500 to 7000 miles at 10 knots, compared to 5700 miles in *Dreadnought* launched in 1875. Two new ships laid down in early 1886 were even more effective as they had range of 8000 miles. Two protected cruisers built in the Powerful-class in 1890s - the lead ship *Powerful* and the *Terrible* - were able to cruise with speed of 22 knots and to steam 7000 miles at 14 knots. The Duke of Edinburgh class armoured cruisers built around 1905 could achieve as much as 23 knots, much faster than contemporary battleships (18,5). In the same time, at the beginning of the 20th century, new battleship, HMS *Dreadnought* was laid down with four shaft-gear turbines gave which it speed of 21 knots. Smaller ships were even faster. The oil-burning Tribal-class was a destroyer class built between 1905 and 1908 capable to retain ultra high speed - 33 knots - for eight hours. As it is often the case when it comes to projects that achieve extreme results, they turned out to be too expensive and the project was abandoned. With the naval race lasted, British - aiming to overmatch new German battle-cruisers - developed HMS *Lion*, capable to cruise with 27 knots due to its 42 boilers. Governmental naval building programs were brought to life to stimulate ship building in Britain as well as in Germany. Fast battleships of 27,500 tons capable of speeding 23 knots with 13-inch guns were constructed under the 1912 Programme in Britain. The 1913 Programme gave life to 5 new coal-powered 15-inch-gun battleships which could achieve speed of 21,5 knots. Furthermore, 8 light-armoured cruisers were ordered, equipped with geared turbines, that set the design up for succeeding classes. The developments of the Industrial Revolution encroached rapidly and profoundly into naval warfare. Coal was essential element of this change.⁹³

Simultaneous developments in guns, engines and ships design made interesting nexus. In 1824

91 Grove, p. 40,41,47,48,52,59,65.□

92 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 280.□

93 Grove, chap. 4.□

horizontal-firing shell gun was developed by the French Henri Paixhans. New type of artillery successfully broke old naval hulk up. The obvious antidote seemed armour plate but wrought iron, or any other suitable material, was heavy. Its weight brought into question logic of wind-powered ships as natural forces were unable to deliver enough power to move armoured ships. While steam engines were at hand it led not only to the race of arms but also to, what can be called, race of armour. The logic of the latter was that ships “required more and more powerful steam engines to drive what soon amounted to floating citadels through the water.” All of these developments – new artillery, armours and steam engines – would not have been constructed without coal. However, they were not specifically British inventions.⁹⁴

One of improvements made in naval artillery was that guns became bigger and bigger. To ensure stability they had to be assembled amidships. Furthermore, masts and sails had to be eliminated either. Hence, wind-powered warfare was no longer possible. Moreover, turrets needed to be powered to be able to target hostile ships. This required additional power that could not be produced with wind. Furthermore, electrical ignition was introduced in 1868. The only way meet supply with demand for power was to increase steam engines' efficiency to provide enough power surplus. It occurred by the 1880s.⁹⁵

The adoption of new artillery design was not easy to obtain. After the presentation given by the German producer of long-barreled, breech-loading steel guns the decision was undertaken to switch the Navy's artillery for breech-loading system in 1879. Not surprisingly, institutions can stimulate or hamper any kind of progress. In this case they turned out to be responsible for delay in introducing these new technologies. For example, in 1881-87 only one-third of the expenditure necessary to convert the RN to breech-loading artillery was authorized. It led to the controlled leak of information to popular magazine about the state of the Navy. The most well-known statement is that "the truth about the Navy is that our naval supremacy has almost ceased to exist", made in September, 1884. The response from the government was not satisfactory for the leaker. Hence, the man who

94 O'Connell, pp. 193–194; McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, pp. 226–227.□

95 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 241.□

stayed behind the leak, John Fisher, who became director of naval ordnance in the mean time, was accorded the legal right to buy from private companies any item that cannot be produced by the official arsenal. In turn, it led to the emergence of military-economic alliance between the Navy and private contractors. "Inevitably, personal links between the circle of technically responsible naval officers and the managers of private firms became very close." It led to the creation of naval building programs since 1880s.⁹⁶

A comparison of British naval building programs (based on the pursuit of a "two-power standard") was coined by McNeill to "Keynesianism before Keynes" and Joseph Stalin's five-year plans due to their duration and character. As these interventions were used to counteract down-swings of business cycles they are used by McNeill to make a link between them and the process of democratization. The first five year plan was passed in the same as enfranchisement occurred, i.e 1884 and, subsequently, in 1889 and 1894. The programmes not only accelerated the pace of technological innovation and development but contributed to occurrence of feedback loop where all parts engaged in the process - arms manufacturers, shipyards, steel mills and related enterprises – were interested in the continuation of naval building. From the early 1880s, metallurgy in Great Britain was in serious problems as new developments in steel manufacturing allowed to combine Lorraine ore with Westphalian coke which led to German steel prices decrease below British production costs. "The Vickers brothers for instance, went into armaments in 1888 because they needed, in the words of the firm's official historian, rescue operation from the bad conditions of traded. It worked wonders for Vickers which grew to be one of the country's largest firms by 1914." What is more, these arrangements made the Navy the main source of invention in Britain due to weakness in technical higher education and bureaucracies' resistance to progress.⁹⁷ In the same time naval expenditures grew almost five times in, what should not be forgotten, the age of almost stable prices.⁹⁸ Hence, despite falling behind Germany and the US, British coal production more than doubled in the last quarter before the I World War from 185 million of metric tonnes in 1890 to 292 million of metric tonnes in 1913.⁹⁹ It leads to

96 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, pp. 265, 268–271.□

97 William Hardy McNeill, "The Industrialization of War," *Review of International Studies*, 8 (1982), 203–213 □

98 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, pp. 286–287.□

99 Stephen Broadberry, Giovanni Federico and Alexander Klein, "Sectoral Developments, 1870–1914," in *The Cambridge*

the conclusion that having secured access to cheap coal British could afford for lack of efficiency and escape from international competition. When the Empire matured its naval power was sustained by increasing input of energy.

Two issues must be raised in conclusion. First, and of lesser importance, is the adoption of oil by Royal Navy in the beginning of the 20th century. The man behind was – mentioned before - John Fisher, who became First Sea Lord in 1904. Obsessed with Germany as future enemy he convinced Churchill to change propulsion fuel. He used, inter alia, these words “Remember oil like coal don't deteriorate and you can accumulate vast stores of it in submerged tanks so as to be free from destruction by fire or bombardment or incendiaries and east of Suez oil is cheaper than coal!” Oil offered several advantages to the RN: refuelling at sea, higher speeds that could be achieved with greater rapidity and broader range of action. The final decision was made in April, 1912, when five oil-fired battleships were included in the naval budget. However, oil is not taken into consideration in this paper as it was introduced too late to make any significant impact on the Navy before 1914.¹⁰⁰

Secondly, British technological domination was not overwhelming, similarly to pre-1830s period. Moreover the starting advantage given by the Industrial Revolution consecutively decreased in time. For example, British were not the first who applied steam engines for maritime transport and warfare. The world's first steam-powered warship was laid down not by British but by Americans, in the end the War of 1812. Americans were also the first who used steamships for warfare.¹⁰¹ The first small river steamer in Russia was built in 1815 while the Russian navy commissioned its first steamer in 1817.¹⁰² As early as in middle years of the 19th century both, France and Britain allocated large share of resource to naval technology.¹⁰³ Hence, “France kept pace, or more than kept pace, with Great Britain in developing its own military-industrial complex.”¹⁰⁴ The first ironclad battleship, *Le Gloire*, was launched by the French Navy in November 1859 while British response HMS *Warrior*

Economic History of Modern Europe: Volume 2, 1870 to the Present, 2010, p. 75.□

100 Daniel Yergin, *The Prize: The Epic Quest for Oil, Money and Power* (Simon & Schuster, 1991), chap. 8.□

101 Lawrence Sondhaus, *Naval Warfare, 1815-1914* (Routledge, 2002), p. 18.□

102 Sondhaus, p. 20.□

103 McNeill, “The Industrialization of War”, p. 204.□

104 McNeill, “The Industrialization of War”, p. 210.□

was launched a year later, in December 1860.¹⁰⁵ In the first industrial conflict – the Crimean War – not only Britain but France also deployed steam-powered ships.¹⁰⁶ Even Sardinia–Piedmont, after joining the war, deployed a small but all-steam fleet.¹⁰⁷ Both Navies, British and Russian, used steamers for their simultaneous operations in the Baltic region during the Crimean War either.¹⁰⁸ As it was mentioned before, in the last quarter of the 19th century not only Britain but also France and Germany launched large-scale programmes aimed at battleship fleet extension. Even at the end of 1884 British advantage was estimated at the level of 27 ironclads in commission against France's 11.¹⁰⁹ It is incomparable to American superiority when it comes to aircraft carriers today. Differently, *Jeanne D'Arc*, designed by French in 1896 was comparable in size and speed to British ships.¹¹⁰ As McNeill notes the RN was conservative and not very prone to introduce steam engines. This mental rigidity gave opportunity for competing great powers, which might build more advanced ships¹¹¹, and, as it was shown, did it. Therefore, it seems clear that other Western great powers were able to stay on par in technological terms.

4.1.1.3 *Steam-powered ships and colonial expansion*

At the beginning of colonial expansion European control did not reach far into overseas land-masses. Because of that inhabitants of the other continents did not have to worry about European technological advantage. Hence, steam engines were applied to steamships planned to be used for river service. “The limits of naval power determined the relations between Britain and China before the Opium War. While English ships could fire upon the Chinese forts at the mouth of the Pearl River-and did so as early as 1637 they could not threaten Canton nor any other important city.”¹¹² As brittleness of iron hull and level of fouling were remarkably lower in hot climates technological developments turned out to be initially more useful in colonial conquest than

105 Sondheim, pp. 73–75.□

106 Grove, p. 36.□

107 Sondheim, p. 62.□

108 Grove, pp. 32–33.□

109 Grove, p. 69.□

110 Grove, p. 84.

111 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, pp. 225–226.□

112 Daniel R. Headrick, “The Tools of Imperialism: Technology and the Expansion of European Colonial Empires in the Nineteenth Century,” *The Journal of Modern History*, 51 (1979), pp. 234–235.□

for competition in more moderate climate. Hence “it was no coincidence that the first iron fighting ships for the Royal Navy, indeed the first iron warships to serve in any major navy, were paddle gunboats for service on the River Niger, ordered in 1840.”¹¹³ As early as in 1816 a paddle steamer was tested by British to check whether its usefulness for an expedition up the Congo River. The ship, unsurprisingly named *Congo*, failed as its engines were too heavy. The ship was finally rebuilt as sailing ship.¹¹⁴

Africa was not the only place where British used steamers as steamboats served in India and South Asia as early as in the first quarter of the 19th century. During the First Burma War (1822–25), which helped to extend British control over Burma, the East India Company (EIC) used steamers as auxiliaries¹¹⁵ and deployed *Enterprize*, *Pluto*, *Diana*, *Irrawaddy* and *Ganges*. The *Enterprize* carried troops and supplies from India, *Pluto* participated in the attack on the Arakan coast while *Diana*, armed with swivel guns and Congreve rockets, was directly engaged in naval confrontation. *Diana's* speed allowed the ship to avoid the fire-boats that were used in Burmese naval tactic.¹¹⁶ Moreover, Asia was the first place in the world where the first all-steam navy was created. In 1837 it was formed based on four paddle steamers belonging to EIC.¹¹⁷ Interestingly, the ships used for conflicts in Asia at this time were not designed as warships. After the navy was used during the First Opium War the steamships returned to function carried out before – operation of the mail service. In the next two decades they served as warships again in Second Burma War of 1852, the Persian War of 1857, and the Indian Mutiny of 1857–58.¹¹⁸ Ships were helpful British to impose rule in less oppressive methods. Since 1834 courses on regular basis were established between Calcutta and Allahabad placed six hundred miles away one from another. Its main goal was to tighten control over the Hindustan so the service was mainly used by officials as tickets were expensive as much as crossing the Atlantic.¹¹⁹

113 Grove, pp. 22–23.

114 Grove, p. 4; Sondhaus, p. 18.□

115 Sondhaus, p. 20.□

116 Headrick, *Power over Peoples*, pp. 186–187.□

117 Sondhaus, pp. 35–36.□

118 Sondhaus, p. 37.□

119 Headrick, *Power over Peoples*, pp. 187–188.□

What marked transition between modern and pre-modern warfare, was the Anglo-Chinese Opium War of 1839-1842 because until then, Chinese land-mass proved impenetrable. When the war broke out British deployed few steamers. Few of them - the *Atalanta*, the *Madagascar*, the *Queen*, the *Enterprize* – stationed already in India. Yet, *Nemesis*, built in Britain turned out to be the key for the operation. It was “armed with two pivot-mounted thirty-two-pound guns, five six-pounders, ten small swivel guns, and a rocket launcher, and she could carry a crew of up to ninety men.” As opposed to other steamers which parts were produced in Britain and assembled in India the *Nemesis* steamed from the Isles. Hence, it was the first iron steamer that passed the Cape of Good Hope. While China was properly prepared for the conditions of the 17th century warfare it turned out to be defenceless against modern steamships. Coal-powered vessels were used to pull the sailing ships of the line into position to fire or to help marines in amphibious attacks. In February 1842 *Nemesis* attacked Canton from the rear making “her way through narrow inland channels which no warship had ever dared enter, destroying junks, bombarding forts, and terrorizing the population”.¹²⁰ The key to win the Opium War was to block the main artery of the Chinese Empire – the Grand Canal, connecting Yangtze River and Yellow River. To block the canal British had to intercept the city of Zhenjiang, when the canal crosses Yellow River. On 16th, June, 1842, British fleet, formed of sailing ships and steamships (including gunboats specifically designed for river work) entered the canal in formation where steamers were intertwined with ships of the line. The fleet captured the city five days later and the Treaty of Nanjing was signed one month after. The Second Opium War, when Beijing was captured, was basically a replay of the First Opium War.¹²¹

While finding the practical preventive for malaria, quinine, was certainly key for the opening of Africa in the second half of the 19th century steamers also played a role. In 1841-42 the British expedition was sent up the Niger river using three iron-hulled steamers, the *Albert*, *Wilberforce*, and *Soudan*. When quinine became popular steamboats were used whenever it was possible not only by explorers like Livingstone and Stanley but also by conquerors. Ships served De Brazza to subjugate the Congo, Dodds in Dahomey, and Gentil in Chad. It is

120 Headrick, “The Tools of Imperialism: Technology and the Expansion of European Colonial Empires in the Nineteenth Century”, pp. 239–243.

121 Headrick, *Power over Peoples*, p. 204,206.□

doubtful that Africa, with difficult topography and inaccessible flora, would have been conquered, if these ventures had to be done on foot. Thus, when quinine was started to be used the first successful mission up and down the Niger occurred in 1854 and regular journeys on the river quickly followed.¹²² “In 1857 the British government signed a contract with Laird to maintain a steamer on the river for five years. (...) From 1857 to the end of the century, steamers had to overcome both the river and the inhabitants of the area.” Thus, since 1863, not only regular patrols were carried out by the gunboat HMS *Investigator* but trading firms itself equipped their ships with armours.¹²³ Steamboats were also employed in other regions of Africa. A sailing ship and a steamship were sent up the Gambia river in 1826 to forestall the French. Other riverboat steamed thirty one trips up and down the river in one year, 1849. It took two years to carry all the parts needed to reassemble the first steam ship unloaded at the lower Congo as it was possible to navigate on its upper part only. Yet, since 1898, when rail-road to interior was completed steamers proliferated quickly. In “(...) 1898 there were 43, and 103 by 1901.” The same operation of disassembling-reassembling had to be repeated for steamers built for Lake Nyassa. The most spectacular application of gunboat fire-power was the conquest of Sudan as they provided fire support lining the river banks.¹²⁴

4.1.1.4 Conclusion

Undoubtedly, application of steam-power to maritime activities raised its effectiveness to unprecedented levels. People, goods and power projection machines could be moved faster and further than whenever in the past. Steamers were helpful when it came to breaking natural obstacles that blocked overseas lands against Europeans. As Headrick argues steamers made a difference between humiliating defeat in Afghanistan in 1841 and victory in China in 1842. Steamships made British able to breach ecological barrier in East Asia which turned out to be the key factor in the failure in West Asia.¹²⁵ Nevertheless, the question remains – how far these applications of steam power were specifically British? The opening of Japan in 1854 by Americans or French

122 Headrick, “The Tools of Imperialism: Technology and the Expansion of European Colonial Empires in the Nineteenth Century”, pp. 245–247.□

123 Daniel R. Headrick, *Power over Peoples* (Princeton University Press, 2010), pp. 210–211.□

124 Headrick, *Power over Peoples*, pp. 213–216.□

125 Headrick, *Power over Peoples*, p. 217.□

invasion on Algeria in 1830 and French use of steamers in sub-Saharan Africa tell us that British were not the only nation that used modern technology. Moreover, they were not even the first nation which applied steam power as main source of propulsion for ships. Robert Fulton's *Clermont* was the first commercially successful steamboat built in America, 1807 but the *Pyroscaphe*, launched in 1783 by the French marquis de Jouffroy d'Abbans, was the first boat powered by a steam engine. In 1787 the *Experiment*, built by the American John Fitch, was launched on the Delaware river. In 1802 the *Charlotte Dundas* steamed on the Forth and Clyde Canal in Scotland.¹²⁶ As a result, as late as in 1837 there could be 628 steamers in Britain, still fewer than in the United States.¹²⁷ This proves that other Western nations were as skilful as British when it came to harness steam-power.

These sections showed that the British advantage seems to be more quantitative than qualitative. This is because “the improvements in engine efficiency that led the steam engine to be dominant motive power in British mining and manufacturing in the middle of the nineteenth century also led to the widespread adoption of steam in western Europe and North America.”¹²⁸ In other words, when steam engines became efficient enough to be applied on large-scale in Britain, including military manufacturing, other states were given the same opportunity. Relative decline which Britain experienced from the late 19th century onwards proves that other nations such as the United States and Germany seized the opportunity.

4.1.2. The Empire and aviation until 1914

Although the British dominance based on naval superiority, the emerging field of aviation must be shortly noticed. As one may expect the Empire, that grew in pre-modern times and on coal, was not very conducive toward this kind of weapon. Albeit the first British 75-ft long and 20-ft-diameter airship was built as early as in 1902, government provided little support for aviation investing a mere \$10,000 prior to 1909.¹²⁹ At

126 Headrick, *Power over Peoples*, p. 179.□

127 Headrick, *Power over Peoples*, p. 186.□

128 Allen, p. 179.

129 Justin D. Murphy, *Military Aircraft, Origins to 1918: An Illustrated History of Their Impact* (ABC-CLIO, 2005), pp. 18–19.□

this time planes were underpowered, hence, one may reasonably assume that British did not feel any risk of invasion. It was only in 1909 when rotary engine, powerful enough to propel planes, began to be produced by the French Seguin brothers.¹³⁰ As the French Louis Blériot has crossed the Channel with a plane on the 25th of July of the same year, the British perception of “splendid isolation” was thoroughly challenged as the island was not cut off from the European continent. Necessity for developing air power became clear, not only for those who were responsible for state's security but also for mass media.¹³¹

Few attempts were made to create air forces before the I World War. The Royal Navy experimented with torpedo-carrying planes in 1913. However, torpedoes' instability after fall into water was not solved before the I World War.¹³² The Air Battalion was officially formed on 1 April 1911 within Royal Engineers. Next years' international tensions - Moroccan Crisis of 1912 and use of bombs by Italians in the Tripolitan War - led to the creation of the Royal Flying Corps in April 1912. None the less unfriendly atmosphere was still there as “without the same level of government contracts as received by their continental counterparts, British aviation firms, such as those established by the Short brothers, T. O. M. Sopwith, and A.V. Roe, remained small and lacked the resources needed for technological innovation. As a result, the British were destined to enter the First World War with both an inadequate air service and an inadequate private aviation infrastructure.”¹³³ When the I World War broke out British had the smallest flight fleet out of all powers. Having 230 planes they remained behind France (317), Germany (245) or even Russia (250).¹³⁴ Hence, aviation did not play important role for British power before 1914.

4.1.3. The role of rail roads

Railroads and steamships are considered as the symbols of the steam era. Powered by the same technology they differed greatly in functionality. The main difference lies in material basis of both, namely, land

130 Headrick, *Power over Peoples*, p. 304.□

131 ,Murphy p. 33.□

132 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, pp. 284–285.□

133 Murphy, p. 35.□

134 Headrick, *Power over Peoples*, p. 305.

and water. While ships have been recognized for centuries as cheap and convenient mean of transport over long distances, range of trains was incomparably shorter. Moreover, as trains did not carry that much means of power projection as ships could do, their main function was transportation of goods and people. By carrying soldiers rails substantially improved the pace of delivering forces to battlefields while carrying goods helped to integrate markets.

What is also important is to find out when exactly trains appeared on the stage. As the first railroads were constructed during the 1830s it is reasonable to argue that could help Britain to retain domination but they did not help it to rise to power. While ships – wind and steam-powered – were important in all stages of the British dominance trains were not. The other difference is that, compared to ships, there was no arms race when it comes to trains between the Great Powers. It means that they were not recognized as a mean of power projection.

Railroads played an important but indirect role in fostering states' power. Trains were usually used to supply military forces at required time and place. The concept of “field” railways – that could be laid quickly to support military front lines - was developed.¹³⁵ As they became critical for imperial infrastructure and warfare railways made the military conflicts more plannable.¹³⁶ It is arguable that the role of railroads for logistics was more important than military. While possibilities of power projection using trains were limited they could bring troops to the battlefield and sustain their presence over the long-term.¹³⁷

4.1.3.1 Military use of railroads

Railroads were important during industrial conflicts of the 19th century. The American Civil War (1861–65) and in the Wars of German Unification (1864, 1866, 1870–71) serve as good examples.¹³⁸ When it comes to the projection of power by British, railways played certain, yet not decisive, role. Troops were carried by rail to cope with the Peterloo incident in Manchester in 1838. Yet, it did not have significant impact on the

135 D Bishop and WJK Davies, *Railways and War before 1918* (Blandford Press, 1972), p. 3.□

136 Black, *Great Powers and the Quest for Hegemony*, p. 114.□

137 Black, *Introduction to Global Military History: 1775 to the Present Day*, p. 53; McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 223.□

138 Black, *Introduction to Global Military History: 1775 to the Present Day*, p. 53.□

British army. There seems to be a certain kind of hostile attitude towards the use of rails for warfare among the British. Lord Kitchener once referred to trains: “That is not our way of working”.¹³⁹

Surprisingly, three decades before the declaration made by Lord Kitchener, British developed novel way of warfare transportation, based on railways. The reason was, lessons regarding logistics not learnt from the Napoleonic Wars. In 1799 specialized transportation task force, the Royal Wagon Train was formed. It operated during the Napoleonic Wars, but the unit was disbanded in 1833 due to economic costs. For this reason the regiments that were sent to the Crimea in 1850s had to organize transport on their own. When Sevastopol started to be besieged the eight-miles long road between the British base at the port of Balaklava and the front line, turned out to be an enormous obstacle. Furthermore, more and more supplies came to the port, hence, increasing the number of problems with logistics. When the most of the horses and oxen died and construction of road was impossible due to the lack of wood British realized they could lay railways down. Moreover, due to simultaneous progress in communication technology the British public was informed about the conditions in the Crimea. “William Russell, the legendary Times reporter who claimed to be the world’s first war correspondent, was blunt: ‘There is nothing to eat, nothing to drink, no roads, no commissariat, no medicine, no clothes, no arrangement: the only thing in abundance is cholera.’” As the British state experienced railway boom the response came from railway investors. The first part of the line had been completed within ten days from the first landing of the builders in January, 1855. It was immediately employed to carry material to build the remainder of the line and to supply the army. Although only the first two miles were served by conventional steam locomotives the line effectively supplied food but not only. The fiercest bombardment until this time which began on Easter Monday, 9 April 1855 involved the firing of 47,000 artillery rounds that were delivered by the railroad. Further bombardments involved 307 guns firing 150,000 rounds in just four days. Despite its short distance the line proved to be vitally important for the siege. It carried on average of 250-300 tons (at the peak 700 tons per day) which was equivalent of around a thousand carloads. Trains were also used to carry injured soldiers away from the battlefield. Hence, the line was the first example of sophisticated and complex system of modern industrial

139 Bishop and Davies, pp. 1–2.□

transport that allowed to build tactical advantage during wartime.¹⁴⁰

Later on, British were the first who laid the first military railway. It was during campaigns in Egypt and Sudan, 1882 when Lord Kitchener, the British Commander in Chief arranged a substantial amount of railway material to be sent out from England. He also ordered to lay a standard gauge line to provide supply route from his base on the banks of Nile. More than a decade later, no less than 20 armoured trains were used during the Boer War. They were “invaluable both in harassing the Boer and in protecting the many miles of friendly and 'hostile' railways being used to supply the advancing British armies as they laboriously 'cleared' Boer territory”.¹⁴¹ Hence, the role of railroads in the Boer War was featured by two things – guerilla war against an army making heavy use of the railways and the most intensive use of armoured trains in any war during the 19th century.¹⁴²

Railroads definitely helped to increase the battlefield effectiveness of cannon which dependent on two factors – deployment and shells. Thanks to steam engines and processes of industrial production the task could be dealt far more effectively compared to pre-modern times. Mechanical power helped not only to produce projectiles but also to deliver supplies from hundreds of miles away in time which was impossible in any earlier age. McNeill puts it bluntly that it “demonstrated once again the vital importance of industrial capacity for waging a new kind of war.”¹⁴³

Railways were heavily used by British for harnessing original inhabitants during colonial expansion. For example in 1868 the Empire sent a task force to Abyssinia to free the British Consul and various missionaries who were locked up by the emperor. The railroad was designed and built to bring supplies inland but the time of construction was that long that the campaign was almost finished when the railroad was completed. Moreover, only four out of six locomotives worked properly while wagons sent from India were prone to break down. A

140 C Wolmar, *Engines of War: How Wars Were Won and Lost on the Railways*, (2010), pp. 22–29.□

141 Bishop and Davies, pp. 1–2.

142 Wolmar, p. 90

143 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 243.

couple of decades later railways were used to retake Sudan. Despite local resistance 3 July 1898 the line reached Atbara, a town located in north-eastern Sudan. Winston Churchill, who observed the event, remarked “though the battle was not yet fought, the victory was won...”. When the final battle took place at Omdurman, well-supplied British troops, supported by steamboats, easily won, even if outnumbered by enemies.¹⁴⁴

4.1.3.2 Economic application of railroad

Because economic power is at the very heart of all Great Powers it is important to investigate the influence of the railway system for the British economy. What makes the account of the role of trains more complicated is the shift in direction of the infrastructural orientation from “the core” to the “frontier of empire”, from national to international, from the centre toward periphery of the Empire.¹⁴⁵

The initial reason for investments in railway infrastructure was necessity to connect ports, indispensable for maritime domination, with the industrial centres of Britain as usually used canals dried up in summer and iced up in winter. But it was soon realized that trains can do much more than simply to carry freight. As they might be used for carrying mail and passengers new options were opened as tourism, commutation and more efficient flow of information became possible.¹⁴⁶ Railways contributed to towns development as only trains were able to address increasing urban demand for food i.e. flour, meat, sugar and vegetables. Usually, demand for food is directly connected with growing population therefore trains were also useful when other necessary goods needed to be delivered, for example raw resources for industry and construction elements – iron, bricks etc. – for houses. Hence, trains influenced economy in two phases. Firstly, it encouraged industrial development which, in turn, led to growth of cities. In second phase, while still providing resources for industry, railroads ensured steady inflow of various resources necessary for enlarged populations.

When it comes to relationship with the British coal industry both seems to have the same source of

¹⁴⁴ Wolmar, pp. 94–99.

¹⁴⁵ M Casson, *The World's First Railway System: Enterprise, Competition, and Regulation on the Railway Network in Victorian Britain*, OUP Catalogue (Oxford University Press, 2009), pp. 39–40.□

¹⁴⁶ Casson, pp. 35–36.□

origin – steam engine - that not only allowed to get water off the ground but also to raise productivity in industry and, literally speaking, moved trains. Therefore, towns – as the British society experienced dramatic structural shift of economic activity from agriculture towards industry – became centres of production and living that required coal for heat and power. In the same time newly invented railroads allowed to carry coal by land, contributed substantially to growth of the inland coalfields and brought domination of water transport of coal to an end. While the coal industry grew by 2,500% between 1800-1914 it reached the highest rate was in 1850s, exactly as a consequence of more effective distribution over the long distances by trains.¹⁴⁷

“Railway projects ‘took off ’ in the 1830s, with a peak in the 1860s. The first Railway Mania year occurred in the period 1844–46. The railways promoted during this period were authorized with a one-year lag in the period 1845–47. There were 119 railway Acts in 1845, 263 in 1846, and 187 in 1847. Many small investors lost their life savings in the speculation that surrounded the Mania. It was a long time before the public regained its confidence in railway investment, but when it did, a second—less virulent—Mania developed. It began in 1861, when 160 railway schemes were authorized. The number rose to 251 in 1865, falling slightly to 199 in 1866. The Mania ended with the collapse of Overend Gurney bankers in 1866—an apparently respectable firm that had been heavily involved in railway finance.”¹⁴⁸

The British railway system was almost completed around 1870. Hence, the financial resources, previously invested in the homeland infrastructure were diverted into investment in the overseas Empire instead. As the construction of railways began in 1850s the Indian railways turned out to be very attractive for investors and attracted more money as any other investment in any European colony. In the end, 1895, the Indian railway network surpassed the British one.¹⁴⁹ “By 1902, British India (...) had 25,936 miles of railroads, more than the rest of Asia put together, over three times as much as Africa, and more both in total and per capita than Japan.” Accordingly, cost of inland transport fell dramatically, from 12 cents in 1830s to 0.8 cent in 1900. Yet, differently

147 BR Mitchell, *Economic Development of the British Coal Industry: 1800-1914*, 1984, pp. 3–4, 329.□

148 Casson, p. 44.□

149 Headrick, “A Double-Edged Sword : Communications and Imperial Control in British India”, p. 54.

than on the Isles, it did not lead to industrialization but to growing dependence on British industry.¹⁵⁰

Despite diversion of capital from the homeland to the Empire demand for coal in Britain could be sustained by development of the Indian railway network. According to Ferguson the process of building Indian railroads created a huge market for British locomotives manufacturers as the majority of the tens of thousands of engines used in India were produced in Britain.¹⁵¹ However, if railway equipment was exported to India it is plausible that energy used to make it was also exported. From this point of view it was part of a wider process of rising coal export due to declining productivity of the British industry. Thus, when the 19th century was coming to the end “British coal was following British capital in leaving the country. Rather than being channelled into domestic manufacturing, it was employed to support the country’s imperial linkages instead.”¹⁵²

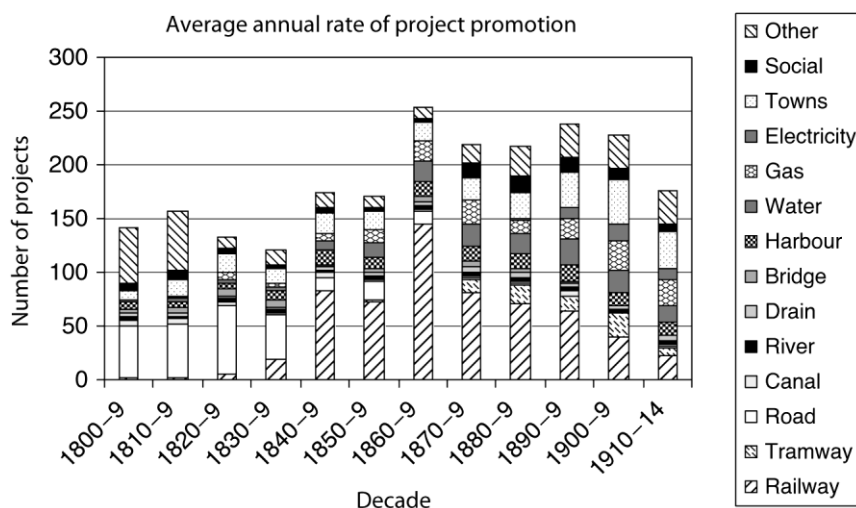
4.1.3.3 Conclusion

It is hard to prove direct link between the role of railways, British coal and British global dominance. It is indisputable that trains could not have been produced and propelled without fossil fuels. What is more often stressed, soldiers, arms and equipment could not have been effectively transported to battlefield without coal as well. Yet more research must be done on this topic to find out how this nexus worked.

150 Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century*, pp. 187, 189.□

151 N Ferguson, *Empire: How Britain Made the Modern World* (Penguin Books, 2004), p. 170.□

152 Casson, p. 50.□



Promotion of large projects requiring statutory authorization in the UK, 1800–1914
(Casson 2009)

The role of trains may be implied on the basis of the number of Acts of Parliament authorizing large projects - big and heterogeneous economic infrastructural investments – as “no entrepreneur could compulsorily acquire land, or otherwise interfere with property rights, without such an Act.”¹⁵³ According to Casson's piece of research, who prepared 10-year averages of the number of the Acts issued there were two peaks, both related to Railway Manias. The first one occurred between 1840 and 49 and the average was 82 Acts. The second peak happened between 1860 and 69 with the average of 144.6 Acts.¹⁵⁴ This information and the overall number of projects promoted may be used together as indicator of the strength of the British economy. What can be seen is that it, more or less, reflects general opinion that the British power peaked, broadly speaking, around 1850s.

Moreover the specificity of the British Isles made British approach rather different from other European countries when it comes to the military application of railroads. While on the continent the railways became the centrepiece of plans to mobilize for war it was not the case for Britain. British plans did not assume that war could take place on its soil. Their strategy was rather different. British were focused on how to manage the railways to make the despatch of troops to overseas ports easier.¹⁵⁵

¹⁵³ Casson, p. 44.□

¹⁵⁴ Casson, pp. 44–46.

¹⁵⁵ Wolmar, p. 142.□

4.1.4. Telegraph. The communications Revolution

While telegraph was not the key technology of this time it fulfilled few important functions for the British empire. Firstly they were essential for the formation of a global economy based on quick flows of information. Secondly, the invention made projection of power more effective as military commanders were able to keep contact with advancing forces. The task itself was not very challenging as the only thing it required was to lie wire. More important was that instructions could be distributed instantaneously.¹⁵⁶

4.1.4.1 History of telegraphs

Simultaneously to developments in transportation of goods and people telegraphs emerged as the fastest way to connect places located far away one from another. Several attempts to connect Britain with other parts of the world were made between late 1830s and late 1850s. The first of them was the cable lied underwater across the Hooghly River in Calcutta in 1839. In 1850 France and the Isles were connected and in 1852 Ireland was linked with Britain. In late 1850s a cable was laid by two steamers to America but its life was short-standing as only few messages were sent before the line broke. However, the most disastrous was an attempt to connect Suez with Aden and Karachi. The cable that was 800,000 pounds expensive was finally laid in 1859 but never transmitted a single message. Only the creation of special joint committee by British government and private enterprise led to significant improvements in surrounding cable constructions and laying methods that allowed to make connection across the waters. Rush to install submarine cables was caused due to the creation of the committee. In 1865 Britain was linked to India by Constantinople and, in 1866 with America. As the problems on the way by Turkey occurred British to laid new lines – one by Europe, Russia and Persia and the second by Mediterranean – and efficient link was finally made in 1870.¹⁵⁷ In India rush to build up telegraph lines started after the 1857 Mutiny. “By 1865, the network was 28,000 kilometers long. In 1900 the telegraph service had over 84,000 kilometers of land lines connecting 4,949 telegraph offices in towns and cities, and carried several

156 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 248.□

157 Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (Oxford University Press, 1981), pp. 158–160.

million telegrams a year (...)”¹⁵⁸

4.1.4.2 *Costs of telegraphs*

If the speed of communication is considered as the measure of development then the second Industrial Revolution started with the spread of telegraphs. Constant improvements speeded up the pace of information and reduce the cost of data transmission. “Curb transmission, patented in 1861, sharpened the signal by sending a reverse pulse immediately after the main pulse. Duplex telegraphy, introduced in the mid-seventies, allowed messages to be sent in opposite directions simultaneously over the same line, thus doubling its capacity. The siphon recorder and other automatic machines replaced the human hand with punched tape”. The reduction in costs was significant. While message sent by the first line to India cost 101 shillings and took several days, three decades later it took half an hour for such a message to reach the destination for the price of 4 shillings. In effects the demand rose enormously as in 1870 only few messages were sent while in 1895 the number rose to two million.¹⁵⁹ Due to completion of the line from Britain to India in 1870 a message travelled six hours, the pace that even dropped in the end of century to one - two hours.¹⁶⁰

4.1.4.3 *Conclusion*

Cable tied empires together providing business communication in the times of peace and valuable tool of diplomacy during crises.¹⁶¹ In the first industrial war telegraphs played military role as “During the Crimean War of 1854-55, a combination of land lines and short submarine cables allowed the French and British governments to interfere actively in the conduct of operations (...)”¹⁶² Even if the role of telegraphs for Britain seems to be clear, detailed research should be conducted to prove importance of coal – on which production of cables relied.

158 Daniel R. Headrick, “A Double-Edged Sword : Communications and Imperial Control in British India,” 35 (2010), 51–65 (p. 53).□

159 Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century*, pp. 160–161.

160 Headrick, “A Double-Edged Sword : Communications and Imperial Control in British India”, p. 56.□

161 Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century*, p. 163.

162 Headrick, “A Double-Edged Sword : Communications and Imperial Control in British India”, p. 55.□

4.1.5. Industrialization and mass production of weapons

Few reasons lied at the back of the firearms revolution which began in the first part of the 19th century - internal rivalries in Europe and the US, rewards for inventors and the application of industrial methods. It made efficiency of all critical features of small weapon - the ease of loading, the rapidity of fire, the accuracy and range of bullets - higher.¹⁶³ Mechanization of weapon production made it possible to alter equipment of soldiers easily as hundreds of thousands of small arms could be produced quickly. "An entire army could be re-equipped about as quickly as soldiers could be familiarized with the new weapon."¹⁶⁴ The scale of production was incomparable with anything before. While it took seven years for Dreyse to deliver 10,000 new weapons ordered in 1840 by Prussian army, newly introduced machines raised the rate to 22,000 per annum.¹⁶⁵ The beginning of mass production of small arms that occurred in Britain after 1855 was direct effect of the Crimean War.¹⁶⁶

It must be marked in the beginning that development of handguns was not the work of art of one nation. A German Dryese invited breech-loading and it was adopted by Prussian army in 1840s and played key role in the battle at Sadowa. But French, as early as in 1866, introduced carbine with far longer effective range than Dryese's one. Yet, it still leaked hot gases. Those who pushed the revolution forward were British who developed the brass cartridge that sealed the breech during fire. In 1869 British armed forces introduced the first model of new rifle – the Martini-Henry. It was “fast, accurate, tough, impervious to the weather, a weapon that made every other gun obsolete.” Yet, the French and the Prussians did not fall far behind and tried to catch up as quickly as possible. The arms race was ongoing.¹⁶⁷

4.1.5.1 New developments in weapons

When considering the role of energy for history of guns one has to remember that all pre-modern weapons were powered only by human and animal muscles. The invention of gunpowder allowed for rapid

163 Headrick, *Power over Peoples*, pp. 257–258.□

164 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, pp. 235–236., p. 235.□

165 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, pp. 235–236.□

166 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 236.□

167 Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century*, pp. 96–98.□

development of front- and breach-loading guns. As it allowed to project assaults with far higher kinetic energy the destructiveness of weapons increased. While bows and crossbows may project arrows with 20-100 J, gunpowder raised the rate to 1×10^3 J for bullet shot from a civil war musket.¹⁶⁸

Energy used to produce an item of weapon is also important. The emergence of mass production of small arms between 1855 and 1870 was a direct effect of the Crimean War.¹⁶⁹ The immediate reason for change in Britain was inelasticity of artisanal production of manufacturers in Birmingham and London. The main problem was chain of orders which began when government signed agreements with entrepreneurs who, in turn, signed agreements with manufacturers. As McNeill puts it bluntly “in 1854-56 no one was willing to wait for decades while thousands of artisans adjusted to a new level of demand.” Additionally, the shift was influenced by the fact the empire was introducing new Minie design of bullet which required far higher level of precision than could be provided by old methods of iron-working. This led to quarrels with manufacturers and made the whole process of production slower. The inspiration for change came from the other side of the Atlantic where mechanized production of weapons started to emerge as early as in 1820s. These new developments reached Britain due to the Great Exhibition of 1851 where Samuel Colt demonstrated the interchangeability of parts of his weapons. Hence, British accustomed with the new technology, were ready to start to transplant into their own courtyard. The process finished in early 1860s, few years after the Crimean War.¹⁷⁰ Yet, “in 1863, four years after it had started production, the Enfield arsenal turned out 100,370 rifles at a time when no special emergency required extra effort.”¹⁷¹ Application of coal for mass production of weapons rose productivity of the industry enormously.

Basically two main inventions of the 19th century in weapon production were ignition and bullets. Dreyse's and Enfield's paper cartridges were too delicate and allowed gases to escape during firing bullets were invented in late 1840s. Metal cartridges were designed to increase accuracy during repeating fire, firstly by the

168 Vaclav Smil, “War and Energy,” in *Encyclopedia of Energy*, 2004, vi, 363–371, pp. 363–364.□

169 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 236.□

170 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, pp. 232–234.

171 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 236.□

French in 1846 which was upgraded by the British and American in the same year, used ever since.¹⁷² "In 1848 Captain Minié of the French army introduced a cylindrical bullet with conical head and a hollow base that expanded when fired." Both, British and French armies started to adopt rifles using Minié bullets in the early 1850s. It raised the range with more than 50% accuracy up to four hundred yards.¹⁷³

Percussion ignition patented in 1807 by the Scottish clergyman Alexander Forsyth was followed by copper percussion caps in 1816 made in Philadelphia. The needle gun was patented for the first time in 1836 by the German Johann N. Dreyse and introduced into the Prussian Army in 1842 which helped it to win the Battle of Sadowa 1866 against Austrians.¹⁷⁴ In 1866 France replied with the Chassepot breach-loading rifle while British started upgrading Enfield rifles in 1860s to breechloaders.¹⁷⁵ Arms race was in place.

Two other developments were decisive for the industrialization of production - the "American system" of interchangeable parts and mass-produced steel. Both were intrinsically connected. There were attempts of parts standardization in the late 18th century in the US. Yet, only the introduction of such steel-making processes like the Bessemer, Siemens-Martin and Gilchrist-Thomas made steel so cheap to use it for military purposes. As new weapons required highly specialized machines which relied on combination of steel, stock of knowledge and coal European firearms could not be copied no longer any more by local blacksmiths. Hence, conquerors gained substantial advantage in Asia and Africa.¹⁷⁶

New patents in metallurgical technology had far-reaching and profoundly enduring effects for mass-produced steel, which, in turn, made cast of uniform and unflawed guns possible. According to McNeill the most important of these licences was patent issued to Henry Bessemer in 1857 which revolutionized steel production. "This permitted large-scale steel production and more exact regulation of its chemical content and structure than had been possible before." In two decades the Bessemer process rooted out traditionally used methods for gun-

172 Headrick, *Power over Peoples*, pp. 261–262.□

173 Headrick, *Power over Peoples*, p. 259.□

174 Headrick, *Power over Peoples*, pp. 258–259.□

175 Headrick, *Power over Peoples*, p. 261.□

176 Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century*, pp. 99–100.□

casting which became obsolete quickly. It allowed the entrepreneurs, like Alfred Krupp in Prussia and William Armstrong in the UK to experiment with new guns of higher accuracy. Important step backward was made in early 1860s when Armstrong's guns turned out to be incapable to smash armour of *Le Gloire*, the first steam-powered French ship. For this reason Royal Navy decided that "muzzle-loading guns were safer, simpler, and more effective against armor than breech-loaders." Hence, not only British but also French stuck to muzzle-loaders for a decade longer than Prussians who introduced Krupp's breech-loaded steel guns.¹⁷⁷ Finally "better propellants and inexpensive, high-quality steels increased the power and range of field of naval guns from less than 2 km during the 1860s to more than 30km by 1900."¹⁷⁸ Newly extended power projection capabilities gave new opportunities in tactic and strategy but also made economies more dependent on cheap energy input.

Spin-off between heavy industry and armed forces was seen especially when it came to naval artillery. Steam engines provided enough power to make armour thicker and thicker. To counteract, guns became more and more powerful. Artillery began to be installed amid to ensure ships stability secured in newly invented armoured turrets. Moreover, cannons hidden behind sheets of metal must be able to aim targets and revolve. This required use of heavy hydraulic machinery. To complicate the issue, electrical ignition was introduced in 1868. All of these developments not only required enormous input of energy to produce warships of new design but also fuel must be available on ships to make them working.¹⁷⁹ The 1871 War, when Prussian breechloaders outclassed French muzzleloaders, finally convinced European armies' decision to change to artillery of new design.¹⁸⁰

4.1.5.2 The role of guns for late the 19th century warfare

Carbines, produced in mass industrial processes, brought two important advantages for European armies. Firstly, tactics changed as soldier could crouch or lie down. In other words infantry could hide and try to save lives. Secondly, rate of fire substantially increased. Soldiers could fire five to seven times a minute, more than

177 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, pp. 237–240.

178 Smil, vi, p. 365.□

179 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 241.□

180 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 242.□

twice compared to Minie.¹⁸¹

Nevertheless, role of guns was negligible until the mid-nineteenth century as small weapons did not provide substantial advantage to Europeans before. During the Xhosa-Boer War of 1799-1802 some Khoisan, equipped with European weapon stole from Boer, were effectively able to stop British advance. What is more “in the first war between the British and the Asante in the interior of the Gold Coast in 1823-31, the British escaped defeat by using Congreve rockets that did more to frighten than to wound the Asante soldiers.” Definitely, Europeans needed more efficient firepower to advance. Only the introduction of breachloaders in 1860s widened the power gap between Europeans and Africans. Breachloaders helped substantially Boers to win the war with Sotho in 1865-1868, loosing a hundred whites against several thousands black. Gatling guns and breachloaded Martini-Henry rifles ensured British wins of the Second Anglo-Asante War of 1873-4 and the Zulu War of 1878-9.¹⁸²

Repeating rifles were used in warfare for the first time in Africa during 1880s. As African states, placed deeper in the interior, retained resistance and began to acquire breechholders the war grew fierce in the 1890s. The British-Zulu War of 1879 was the first one that brought large number of fatalities related to the use of weapons of new design. “Half of the 50,000 Zulu warriors who fought were either killed (8,000) or wounded (16,000) (...) in this war that lasted only six months.”¹⁸³ While European forces were, at best, few thousands people, large African armies numbered in the tens of thousands. Yet, tactics of the natives, suited for the confrontations with other Africans, did not evolve quick enough to match that of Europeans.¹⁸⁴ The best-known confrontation where African tactics failed against modern warfare was the Battle at Omdurman (2nd, September, 1898). British, using Maxim guns, repeating rifles and the support of the gunboats shot eleven thousand Mahdists loosing 28 British and 20 Egyptians (overall 48 dead and 382 wounded). This huge discrepancy in

181 McNeill, *The Pursuit of Power : Technology, Armed Force, and Society Since A.D. 1000*, p. 245.□

182 Headrick, *Power over Peoples*, pp. 269–272.□

183 H Wesseling, “Imperialism & the Roots of the Great War,” *Daedalus*, 134 (2005), 100–107 (p. 103).□

184 Headrick, *Power over Peoples*, p. 273.□

fatalities can be attributed to the superiority of the European firearms.¹⁸⁵

One could reasonably ask – why Africans did not use the vast amount of resources they have had at their disposal. The answer lies in the structure of the African metallurgy that was very different from the European. As “the wheel was practically unknown, and animals, wind, and falling water were seldom used as sources of energy” people were the only source of power. Due to poor ventilation African furnaces were not hot enough to produce cast iron. Hence, blacksmiths hammered the spongy bloom to transform it into wrought steel or iron. Its quality was high enough for hand tools, yet not for barrels or precision parts. Moreover, the cost of African iron was too high and supply too low to meet the demand for guns. Hence, European firearms were far too cheap to compete with. Certainly, cheap energy must have contributed to this low price.¹⁸⁶

4.1.5.3 Conclusion

Europeans, when deprived technological advantage, paid far higher price for conquests. Or, in other words, if indigenous people had access to the same technology they could be as effective as European conquerors. The case of the emperor Menelik's Ethiopia who created the modern empire-state that had been completed by 1898. It clearly shows that Africans equipped with European weapons and trained in using them were able to stop European expansion. Ethiopians can even be regarded as the only African society taking part in the Scramble for Africa as they conquered neighbouring lands.¹⁸⁷ What seems clear is that firearms revolution was not specifically British at all. All countries contributed to the arms race stealing, spying and investing in research and development. Hence, cheap energy could explain not the qualitative but quantitative advantage of the British. Moreover, the arms race started in 1840s, near to the peak of British power. Therefore the mass production of firearms cannot be used as a factor explaining British rise to power.

185 Headrick, *Power over Peoples*, p. 279; Wesseling, p. 103.□

186 Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century*, pp. 108–109.□

187 Headrick, *Power over Peoples*, pp. 289–291.□□

5) Conclusion

Current shale gas and 'tight' oil revolution has received much attention and spurred hot debate on the role of energy for a quest for power. Astonishingly, to the best of my knowledge, there is no paper making an attempt to explain in a clear manner why access to energy resources is considered as an important factor for all the great powers. I would argue that one should look for the explanation in the past as the modern world and warfare have started at the turn of the 18th and 19th centuries when fossil fuels based industrialization began. Hence, this paper is focused on Britain which industrialized as the first country in the world and dominated the global quest for power before 1914.

Based on information on coal and British empire in late 18th, 19th and early 20th centuries two assumptions can be proposed, namely, (1) energy is a necessary but not sufficient condition for an industrial great power; (2) cheap energy provide capabilities for quantitative (yet not qualitative) advantage for a state endowed with vast energy resources. In other words, an industrial great power should have easy and uninterrupted access to cheap energy to be able to produce a high number of weapons than competitors.

According to this thesis the history of British domination – the first modern global power – is divided in two periods. The first investigates the period of global hegemonic wars i.e. 1763-1830 while the second embraces the years 1830-1914. Noteworthy, that time-frames for political, economic and energy history and history of technology are different. As the periodization applied in this thesis is rooted in the history of technology, it regards the 1830s, when industrialization of war began, as the turning point. However, in economic history no such event can be found as the Industrial Revolution was gradual process lasting dozens of decades. Accordingly, no single turning point in energy transition from renewable to non-renewable energy sources exists as they have been also gradual in character.¹⁸⁸

As the British role in international politics in 1763-1914 is very often described as hegemonic the first

188 Vaclav Smil, *Energy Transitions: History, Requirements, Prospects* (Praeger Publishers, 2010), p. VIII.□

part of the thesis makes an attempt to assess whether it is correct. Firstly, the notion of “hegemony” itself is defined. This part of text describes how definitions of hegemon evolved. A remark is made that the point of gravity has moved from structural features of a hegemon to definitions based on social characteristics. I argue that these theories are improper for this thesis as the paper is focused on material capabilities. Therefore, the only theory of power that goes along historical materialism is Kindelberger's hegemonic stability theory which puts pressure on material contexts of hegemony - economic or technological pre-dominance and expanding economy. Secondly, several papers and books in the fields of international relations and history are briefly reviewed, looking for opinions of various scholars whether Britain was a hegemon. There is scientific consensus that Britain possessed unique features that gave it dominant, position in the international system in 1763 - 1914. Three of them seems to be the most important - domination on seas, leadership in industrial production and economic power. These features of Britain goes along theoretical background provided hegemonic stability theory. However, a reservation must be made. Indicators do not fit to the perceived position of Britain which is said to peak around 1870s. Differently, quantitative research in the field of political science suggested that its marine power peaked in 1815-1830. At this time the US GDP was 108% and Russian was 90% that of the British. Hence, it is hard to find empirical evidence to back up the statements arguing for the British hegemony if it is defined as an overwhelming advantage of one state over others. Hence, a better word to describe British position would probably be “dominance”.

The interesting thing is that succession of pre-modern technology with industrialization – or at least industrialization of warfare – seems to weaken British dominance. In other words, the peak of British power occurred around the Napoleonic Wars when the Empire was able to dictate the conditions of peace, being backed up by the Navy, the merchant fleet and industrializing economy. However, when the process of industrialization and mass production spread around Europe and the US the position of Britain fell. French never lost their knowledge base and were, more or less, on par with British when it came to military research and development while unified Germans successfully mastered application of trains for warfare. This suggests that the advantage that Britain achieved due to early industrialization was not turned into long-term hegemony. Strictly speaking,

while retaining quantitative domination Britain lost its qualitative advantage which previously led to the Industrial Revolution. While its maritime based empire was built in pre-modern times coal was necessary to retain the status quo in modern, industrial times. Hence, coal cannot be considered as the factor that lifted British up or as the endowment that changed the world's fate. In other words, the evolution of British political power seems to be separated from the process of industrialization.

The second and the third parts of the thesis make an attempt to trace interaction between resource endowments – namely, coal – technological development, economic power and the political position of Britain.

The first section of the second part explores the role of the wind-powered RN and the beginnings of steam-powered RN. Conclusion here is that it was not necessary to propel ships by coal to achieve global marine domination. In other words British got privileged position by more effective management of fleets compared to competitors, not by the industrialization of ships. The important factor in the rise of British maritime power was strong and long-term commitment of the imperial government to invest money in the RN that was acquired by new ways of taxation. Hence, the second section analyses whether coal contributed indirectly to increasing financial resources. The assumption is that coal as the fuel for productivity-raising machines broadened tax base and provided more money that could be used for war. Yet, the reviewed articles suggest that manufactured goods did not influence the overall British income as much as I expected.

In the second part, which encompasses the 1830s - 1914, makes a review of various material contexts of British power that can be connected to coal, namely: ships, railways, telegraphs and weapons. For a reason two important developments are excluded: aviation and torpedoes. Although both were invented at the turn of the 19th and 20th centuries, they did not influence the global quest for power that much before 1914. As European competitors stayed on par when it came to technological progress, coal supported naval domination established in pre-modern times by ensuring quantitative advantage in the number of ships, expressed later by "two-power" standard. While the application of railways for military reasons was limited, economic use was more extensive. For example, as trains carried more and more goods and resources from the shores to the inland of the Isles

demand for coal increased. The Indian continent would have not been exploited and subjugated that effectively without railways which, in turn, would have not been made without coal. Mechanization of the firearms' production can be considered a factor that sustained British domination but not as the main pillar. Progress in this field was actually made on international level, it was not specifically British. Again, coal could support quantitative advantage in the number of weapons. However, initial qualitative advantage that arose from the early industrialization was not directly translated into gain in political power over other European states.

A number of final conclusions is to be made. Firstly, the topic itself must be considered on two different levels of analysis, namely the British versus the European Concept of Power and British/the West versus the Rest, due to different dynamics between both. As it was shown coal provided quantitative but not qualitative – and not overwhelming – advantage for the British when it comes to competition with other European nations. However, on the global scale, Europeans - as a whole - conquered distant lands due to qualitative superiority in war machines produced in industrial processes. Interestingly, when Headrick compares British conquests in China and Burma to French advance in Algeria and British in India he comes to the conclusion that the former conquests were easier, as in the latter confrontations defenders possessed more or less the same technological and organizational capacities.¹⁸⁹ Hence, Europeans, deprived of their technological advantage, paid the far higher price for conquests. Secondly, as the British built their superiority in the late 18th century, pre-modern times, it goes too far to say that their empire was the first industrial one. The Empire did not need steam power to achieve domination on seas but relied on institutions, including extraordinary financial support. It suggests that institutions were more important than factor endowments (coal). While it is true that the British led the Industrial Revolution this is not the case when it comes to industrialization of warfare as it was product of transnational sociopolitical processes.¹⁹⁰ Thirdly, British lost their position when other European nations started to industrialize. For example its share in the global number of ships exceeded 50% for three periods only 1720–24, 1810–34 and 1855–59. “A 50 percent share of the capabilities in the system provides a nice focal point

189 Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century*, pp. 92–93.

190 Herrera.□

because it signifies that one state controls as many naval capabilities as all other great powers combined.”¹⁹¹ The British and French both used steamships in Crimea. The French also built steam-powered warships quite early.¹⁹² This suggests that British domination is easier to be found before the 1830s – which marks the beginning of the industrialization of warfare – than after. This leads to the most important conclusion – that the British Empire can be considered as the last pre-modern empire as its power was built through pre-modern means. From this point of view both, the process of economic industrialization and the industrialization of warfare are to be seen as processes which sustained, yet not created, British domination. Hence, it seems to be wrong to consider British empire as coal-based.

191 Levy and Thompson, p. 27,28.□

192 Grove, pp. 29–39.□

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Education

2012 – 2013	MA Global History and Global Studies (expected) , Institute for History,
2011 - 2012	MSc in Global History , Economic History Department, London School of Passed with dissertation graded a “distinction”, online transcript available on demand
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05-06/2013	Intern at the Polish Mission for United Nations, Vienna My duties involved attendance and writing reports from international meetings and conferences in various international organizations such UNIDO, IAEA, CTBTO.
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Full proficiency in MS Windows, the Internet and graphic design software, good knowledge of MS Office / analytical and logical thinking / experience in international environment / writing / strong commitment for work / languages: Polish: native, English: C1, German: A1

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