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I. INTRODUCTION

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To use a familiar metaphor, we will contend that both analyses allow scholars to see a few trees but not the entire forest of a coal-fired British imperial capitalism that rested on carbon energy, financial innovation, and near-constant warfare abroad. We will claim that both analyses largely sidesteps crucial geopolitical factors to focus almost exclusively on developments *within* Britain that contends led to the mass exploitation of coal. After exploring Britain's geopolitical context, we will then challenge the *internal* transition thesis that coal was primarily pursued so that labour could be more fully and perhaps more easily exploited. We do so by considering the rise of the fiscal-military state and its

[1] We are aware that the literature is vast and that this is not a complete list of citations, but we hope it is reflective of the main debates.

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connection to capitalization, coal, and the expansion of credit within a growing international and outward looking empire. To substantiate our argument, we have divided this article into four main sections and a conclusion. In the first section, we engage with the Malthusian/Neoclassical principal thesis that the transition to coal and steam power had to do with the scarcity or price of wood. The second section addresses the silences we find troubling in both explanations particularly the lack of geopolitical context for the energy transition to coal and steam power. The third section discusses a second major silence: the rise of Britain's fiscal-military state and its connection with coal, capitalization, and the expansion of credit. The article ends with a brief conclusion.

I. THE DEARTH OF TIMBER THESIS REVISITED

Like Marx (1867)[1976] and Polanyi (1957) before him, Malm's intellectual journey sees him return to England not to find the transition to capitalist industrial production or the emergence of a market society *per se*, but to uncover how a 'fossil economy' developed. Malm is clear that his motivation is to trace why global society finds itself in a climate emergency. Not surprisingly, he argues that while there are other contributors to climate change, the combustion of fossil fuels is *the* leading cause of global warming (Kenner and Heede 2021; IPCC 2022). This is why we must return to Britain, because it is the birthplace of the first nation to exploit coal *en masse* (Nef 1932 and 1977; Wrigley 2010). For Malm, the historical and intellectual task is to uncover why Britain turned to producing and consuming coal in great quantities, when: a) coal was well known and used in antiquity for thermal energy in Britain; b) other nations did not adopt coal and steam power in any great quantities until much later and c) the energy from wood and water appeared to be cheap and abundant while the steam engine was costly and often unreliable until it was modified and improved upon to increase its efficiency.

In his quest to advance a Marxist explanation for the emergence of a 'fossil economy', Malm's main intellectual opponent is the demographic scholar E.A. Wrigley's (2010) *Energy and the English Industrial Revolution*. Wrigley, among others, argues that the increasing reliance on coal as an energy source largely resulted from necessity (see Thomas 1986; Smil 1994; Malanima 2006; Freese 2016). The reasoning here is that over centuries, Britain denuded most of its forests (or had certain forests protected by Royal decree) causing the price of timber to increase as emphasized by Nef's seminal research (1932 and 1977). Mounting prices for timber due to scarcity, then, was the chief reason for turning to the energy provided by coal. Malm (2015) takes serious issue with this argumentation as his hypothesis articulates that the transition to coal and steam power was mostly about the capitalist desire to exploit wage-labour more fully in pursuit of surplus value in an industrializing Britain. According to Malm and some Marxists, this is the root and continued reason for our current climate predicament (Angus 2016; Foster 2022)). Unlike labourers who can be troublesome due to the limitations of their biology or turn to bright ideas like organizing as a collective (union), the steam engine, while requiring a feedstock of coal, did not complain, can work continuously and does not organize to contest working conditions or pay. Most importantly, steam power did not suffer from environmental limitations (the tide) as the British waterwheel did and was able to expand and intensify the working day and thereby further the exploitation of human labour-power (Malm 2013). To be sure, these reasons are more than plausible for the increasing adoption of coal and steam power. But our question is whether these were the *primary* reasons for the transition to greater coal production and consumption? We think not, and to demonstrate this, we must take a closer look at Malm's critique of Nef's 'dearth of timber' thesis.

Malm argues that the leading reason for exploiting more coal and the development of steam power was to subordinate labour power not a country-wide dearth of timber. The evidence he provides is drawn from economic historian R. C. Allen's (2003) thesis who argued that the British industrial elite suffered from high labour prices not high timber costs. Malm also draws on the

works of Hammersley (1957), Flinn (1959), and Steinmueller (2013) who predominantly claim that there was no timber scarcity in relation to using it as a fuel source for ironworks. While Malm admits that there was indeed a popular discourse on the dearth of wood in the two centuries leading up to 1700, he claims that the timber famine was mainly restricted to London with perhaps additional regions being affected from time to time (Malm 2016: 226). In short, Malm claims there was no serious nationwide wood nor energy crisis and therefore, crucially, no *dire need* to turn to coal to provide more energy for industrialization.

On closer inspection, we argue this is not only a simplification of Nef's (1932) thesis but believe these arguments do not sufficiently demonstrate that the dearth of wood thesis is completely inaccurate. We find it strange that Malm attempts to refute the scarcity of timber in England by falling into neoclassical reasoning by focusing on commodity prices as the drivers of history. For example, we know both historically and presently that commodity prices are not reflective of their abundance, scarcity, nor productivity but have much to do with power relations that are embedded in their production, distribution, and consumption (Nitzan and Bichler 2018). Moreover, capitalists are not rational choice actors who only use price as a key determinant for the selection of their energy resource as neoclassical historians would have us believe (Thomas 1986; Clark and Jacks 2007; Wrigley 2010; Allen 2003). The dominant energy source within an energy system is often dictated domestic elites, geopolitics, profitability and accessibility (Di Muzio 2012; Christophers 2021; Hager 2021). Furthermore, even if there was an abundance of timber at inexpensive prices, it does not follow that industrial capitalists would not have turned to coal anyways. In this sense, Malm largely downplays both scientific and technological revolutions taking place in England and elsewhere and the superiority coal has over both timber and water (as sources of energy) in both the economy and in everyday life **(**Hill 1976; Cipolla 1977; Smil 1994; Goldstone 2002, 2013; Vries 2013 Freese 2016; Ashworth 2017).

We find it interesting that Malm would dismiss the 'dearth of wood' thesis so quickly when Marx's intellectual curiosity into studying capitalism began with investigating the 'theft of wood' in Germany in 1848 (Bensaïd 2021). The debates on growing timber famine in both England and some parts of Europe, especially in urban centres, started in the early 16th century which correlated with significant population increases (McNeill 2004; Malanima 2006; Warde 2006; Moore 2015). This is not to argue that Malthus' 1798[1998] thesis is correct - whereby when a population starts to grow exponentially, so too does the consumption of resources and thereby the rise of resource depletion.[2] Britain's 'timber famine' was even highlighted by Engels (1845) and other Marxist scholars who have argued that the timber famine in England was the result of proto-industrialization and the need for iron for the agrarian revolution and for wool and husbandry (Brenner 1976; Warde 2006; see also Watson 2021). Werner Sombart (1916)[2019] highlights that pre-industrial England and Europe could be considered the 'Wooden Age' due to the fact that industry, war/plunder, trade, and social reproduction were largely dependent on access to wood and clear-cut arable land. In 1650, already '170,000 to 200,000sq km of forest land had been cleared' which was roughly 35 to 40 'percent of the continent's whole area' (Malanima 2006: 107). As a result, both England and Europe's 'dearth of wood' is much more multifaceted than just increases in population/consumption or prices but rather, fundamentally, about social transformation, power, and inequality, especially in Britain where war and finance merged in a new and interesting way as will be discussed.

Finally, Malm follows the more controversial opinions of Hammersley (1957) and Flinn's (1959) research on the fact that iron furnaces did not deplete England's wood reserves in any significant way. True or not, neither Hammersley, Flinn nor Malm address the larger transformations in

[2] As a long-standing critique of Malthus and Malthusian based scholarship is the consistent overlooking of how social hierarchies and property relations are fundamental in shaping and reshaping resource scarcities and the gross unequal distribution and consumption of resources across human histories (Angus and Butler 2011; Di Muzio 2017).

Britain's economy that intensified its dependence on wood consumption such as the rapidly expanding wood-dependent industries (e.g., brewing, furniture, shelter/heating, iron, glass, arms, etc.) and the most important of all, shipyards and shipbuilding all required vast amounts of timber (Albion 1952; Nef 1932 and 1977; Fouquet and Pearson 1998; Melby 2012; Moore 2015 Freese 2016; Ashworth 2017; Satia 2018).[3] As Albion (1952) and other historians note, there was indeed a timber problem for the British Royal Navy who had an insatiable thirst for evermore hard and soft timber (McNeill 2004; Davey 2011; Ashworth 2017; Reiver 2019). This is reflected in how King James I, in May 1615, banned the use of timber, especially oak, as fuel by manufacturers that were unrelated to the Royal Navy or shipbuilding industry (Ashworth 2017: 90). This sparked the search for fuel alternatives domestically as well as timber abroad.[4] In 1794, the British Navy consumed almost a quarter of all wood that Britain had circulating in the economy (Davey 2011: 161). As a result, Hutchinson (2012: 581) notes that Britain was a large wood importer, reflective in 1705, when Britain's trade imbalance with the Baltic countries for predominantly timber, iron, and grain was around £500,000 and by 1800 it rose to £2,500,000 (see also Sven-Erik Åström 1970). Lastly, Britain attempted to make their colonies, now known as Canada, the United States of America, India, and the Caribbean Islands into 'Timber Colonies' and 'Naval Stores' to maintain their global navy supremacy in terms of both shipping, trade, plunder and war (Albion 1952; Davey 2011; Melby 2012; Reiver 2019; Smith 2019).[5]

Therefore, by examining Nef's (1932 and 1977) 'dearth of timber' thesis as connected to the ways Britain's economy and social reproduction were fundamentally changing, this leads to a better explanation for the rise of coal consumption within England. As a result, one of the mistakes Malm makes is confusing the terms *energy transition* and *energy addition*. In the former, one source of energy completely substitutes for another, making the original energy source obsolete or used only parsimoniously. In the latter case, the original source continues to be used, perhaps less so to be sure, but is not wholly replaced by the new energy source – in this case of course, coal (York and Bell 2019: 1). In the end, total energy production and consumption increased due to new sources coming online – and coal was a powerful source of energy unlike any other until oil started to be produced in commercial quantities in the late nineteenth century. As Malm would likely agree, we must realize that sources of energy are born in pre-existing power relations of domination and resistance. While there was no discourse of 'economic growth' in early modern England or during the time of the Industrial Revolution, there was undoubtedly a growing concern with 'improvement' for profit by capitalists and state officials (Wood 2002; Cook 2018). Malm would doubtless agree, but it matters how we interpret this capitalist imperative as it relates to coal, the accumulation of money, and the rise of a fiscal-military state with increasing imperial tendencies. We will discuss these factors in more detail below, but for now, we turn to the concept of exploitation and the geopolitical context for the rise of a coal-fired Britain.

II. EXPLOITATION AND THE GEOPOLITICAL CONTEXT FOR THE RISE OF CARBON CAPITALISM

As mentioned above, what Malm presents as his evidence for the transition to coal is an *internalist* Marxist argument for the transition to coal in Britain. The *primary* motive of the capitalists, he contends, is the control and domination of

[3] For example, 'some six thousand mature oaks selected from the forests of Kent and Sussex, the equivalent of a hundred acres of forest, were needed to build Victory alone. In addition, softwoods such as fir and pine—all unavailable in sufficient quantity on the home islands—were imported for the building of the keel, decks, masts, and topmasts' (Reiver 2019: 467).

[4] King James I found anyone 'defying the law was subject to the death penalty' and were instructed to use coal (Ashworth 2017: 90).

[5] Hemp, iron, pitch, tar, flax, and most important of all, timber, 'were the ingredients of British naval, commercial, and economic power. These commodities were as important as oil is in the twenty-first century. British security rested upon a functioning Royal Navy, to protect it from invasion, to protect its maritime trade, and to blockade enemy shipping' (Davey 2011: 161).

labourers as a going concern. This is because Malm, following Marx, believes that the source of surplus value (capitalist profit) is the exploitation of labour power. As a Marxist, he must then believe that the concept of 'exploitation' he uses means that workers are not paid the full value of their labour power/time during any given production process. So, if the drive and desire of the capitalist is to accumulate more profit, then having more workers to exploit should also be a key goal since workers are the source of all profit in Marxism (Nitzan and Bichler 2009: Chapter 6 and 7). In addition, Malm believes that the transition to coal facilitated the exploitation and domination of workers. But does this contention hold water? In this section, there are at least two main points that challenge Malm's view on the exploitation of labour and transition to coal and steam power. The first is an alternative non-Marxist understanding of the concept of 'exploitation' and the second is examining the geopolitical conditions in which England/Britain finds itself during the transition to capitalism.

Let's take the issue of exploitation first. The English term originates from French and generally means to take advantage of someone, a situation or something for the purpose of profiting or benefiting oneself in some way (Di Muzio 2013: 156). Notice that this is not Marx's definition. For Marx, exploitation means workers in industrial production are not paid the full value of their labour time/power and this is *the origin* of the capitalist's profits – hence the justification for revolution.[6] This is important because if we follow the former definition rather than Marx's, we do not have to find capitalists waiting in the wings to garner more labour power to make ever greater profit. What this suggests is that the *primary* drive of transitioning to coal was not necessarily the exploitation of labour for profit. Let us be clear. Our argument is not that 'exploitation' was an absent factor in a hierarchical society dominated by a class of variegated capitalists. The working class was indeed exploited in 'satanic mills' and other places of work for profit (Polanyi 1957). What we dispute here is that the profit of the capitalist is *solely* the result of exploiting the unpaid time of industrial labourers. The fact that there are mounting fears that automation will replace some forms of labour is telling enough (Banes, Cotton, and Kumar 2022; Holzer 2022). If we are correct, then Malm's main argument starts to break down, and we must look for other historically convincing reasons for the transition to coal in England/ Britain.

While debatable we may be able to distinguish between different forms of capitalism as Marx (1867)[1976] did between commercial and industrial capital. Commercial capitalists are said to rarely produce anything and earn their profits by buying goods cheap in one place (e.g., spices) and selling these goods in another market at a higher price (Wallerstein 1974; Banaji 2020). Industrial capitalists, on the other hand, are said to be the true capitalists whose workers are directed and commanded to produce industrial goods for the market (Brenner 1977; McNally 1988; Wood 2002). But while we can make this conceptual or even analytical distinction, both operate on the principle of cost-plus accounting that originated with double-entry bookkeeping which emerged in Italy in the 15th century (Braudel 1983). In our view, this accounting method has been continuously refined and now more or less rules the world as there are no capitalists or governments without their accounting books. So, the commercial capitalists – even though they might not be exploiting labour in a factory – make their profit by adding on to the original price of the goods they purchased for sale in a foreign market. In other words, the power of commercial capitalists rested on their ability to carry out long-distance trade and administer the prices to consumers who are unable to carry out this type of trade. There was no point for a commercial capitalist buying a hundred ounces of cinnamon in Sri Lanka for £100 to return to London and sell the same hundred ounces for £100 if their end goal was the accumulation of money. The price will always be marked-up by some percentage. In a similar fashion, industrial capitalism is a cost-plus

[6] We sidestep the infamous transformation problem that has afflicted Marxism here (Marx had to convert labour time into prices, not the reverse) (Howard and King 1989).

accounting system (Douglas 1922). Chieftains of industry figure out the total cost of their products – with labour being a major cost – and add a markup to achieve a certain profit target. This may have been a bit wonky in the beginning for a variety of reasons not explored here, but it is normal capitalist practice today (Vuocolo 2022). What this suggests is that if we are correct, and profit is a result of cost-plus accounting rather than the Marxist understanding of exploitation as unpaid surplus labour. Therefore, Malm's argument that transition to coal starts to breakdown and a stronger analysis would be to investigate how coal and later on carbon energy was/can be used to exploit (take advantage) and oppress working, gendered, racialized populations globally which happens repeatedly in capitalism (Nore and Turner 1980; Debeir Deléage, & Hémery 1991; Huber 2013; Preston 2017)In essence, the Marxist interpretation of exploitation has not ever been proven and cannot alone explain the level of prices and capitalist accumulation (Sweezy 1991; Nitzan and Bichler 2009: Chapter 6 and 7).

What we do agree with is that capitalism is all about accumulating more money and this should be our starting point, not the desire to exploit more workers *per se*. Workers are certainly integral to the functioning of any economy from their work contributions to their purchasing power, but we contend they are not the *direct or immediate* source of capitalist profit. Instead, their labour is a *cost* to the capitalist, which is why, in the first place, there is an ongoing desire, where possible, to cut labour costs. In addition, we can verify this empirically. If Marx and his followers are correct, we would expect to find a strong correlation between the number of employees and the profitability of a firm **(**Nitzan and Bichler 2009: 173). Table 1.0 ranks the top ten Fortune 500 companies in 2021 by profitability and shows the number of employees they 'exploit'. As is clear to see from the data, there is no correlation between the number of employees and a company's profitability. Table 2.0 is even more damning and ranks the top ten firms by number of employees and shows their level of profit in 2021. Again, we should expect to find that there is a strong correlation with the number of employees per firm and their profitability if the exploitation of labour time is indeed the 'true' source of capitalist profits.

Table 1: Top 10 Fortune 500 Companies by Profit and Number of Employees[7]

Company	# of Employees	Profit (m)
Apple	147,000	$57,411
Saudi Aramco	79,800	$49,286
SoftBank Group	58,786	$47,052
Industrial and Commercial Bank of China	438,787	$45,783
Microsoft	163,000	$44,281
Berkshire Hathaway	360,000	$42,521
Alphabet	135,301	$40,269
China Construction Bank	373,814	$38,282
Agricultural Bank of China	462,592	$31,293
Meta Platforms	58,604	$29,146

[7] https://fortune.com/global500/2021/search/?fg500_profits=desc (accessed 4/8/2022).

Table 2: Top 10 Fortune 500 Firms Ranked by Number of Employees Showing Profit[8]

Company	# of Employees	Profit (m)
Walmart	2,300,000	$13,510
Amazon	1,298,000	$21,331
China National Petroleum	1,242,245	$4,575
State Grid	896,360	$5,580
Hon Hai Precision Industry	878,429	$3,456
China Post Group	827,231	$4,698
Volkswagen	662,575	$10,103
US Postal Service	569,987	-$9,176
Sinopec Group	553,833	$6,205
Compass Group	548,143	$169

The data is telling – the corporations with the highest number of workers do not rank in the top ten companies by profitability. In fact, the US Postal Service with 569,987 employees ran at a loss! Again, this is crucial for Malm's argumentation because he wants to persuade us that the transition to coal was all about the exploitation of workers and therefore greater capitalist profits. But if we are correct that the origin of profit is in cost-plus accounting and the ability and institutional power to markup prices, then we must look at other reasons for the unique exploitation of coal in England rather than capitalists yearning for the exploitation of the working class. Part of the answer, we contend, is in understanding the geopolitics of the time[8].

As many scholars have argued, capitalism must be viewed as having geopolitical origins (Bhambra 2021; Heller 2011; Anievas and Nişancioğlu 2015; Di Muzio 2015; Moore 2015; Di Muzio and Dow 2017). This does not mean that the internal social relations of a political community are of no interest – far from it – which is the entire point of focusing on England's exceptional transition to coal energy and how it fuelled its particular configuration of capitalism. But these relations are not isolated, they are international, and England was deeply embedded in an international system of violence and money at least since the Viking raids (8th century). Arguably, this international engagement escalated during the so-called 'age of exploration', colonization and the transatlantic slave trade (Mies 1986; Vries 2013; Di Muzio 2015; Moore 2015). Moreover, since capitalism is primarily about the accumulation of money, we argue here that we should focus on violence and the acquisition of money (McNally 2020). As a more complex market economy started to develop as commoners were increasingly dispossessed of their customary right to land and subsistence, creating mass pauperism, so too did another problem arise (Marx 1876[1976]; Polanyi 1957; Thompson 1963). This problem was the dearth of money, and at least by the early 17th century, this was recognized as a stubborn fact (Wennerlind 2011). The main reason for the dearth of money problem was that by custom and faith, 'real' money was thought to be gold and silver – two metallic substances limited by their scarcity. This fact not only afflicted England but also most Western European countries. If the accumulation of money and power was the goal of the upper echelons of the European social hierarchy – and it was - then more gold and silver needed to be found. Lacking their own abundance of gold and silver mines, Europeans set out on a quest to find these metals

[8] https://fortune.com/global500/2021/search/?fg500_employees=desc (accessed 4/8/2022).

abroad - largely by violent acquisition. Columbus was the first, and while he may have been looking for a western route to the eastern trade with Asia, it is also clear from his diary that what he wanted most was gold (Vilar 2011: 63ff). The relationship between gold and power was inescapable – it raised armies, it serviced debts and it built castles and palaces – physical displays of power over subordinates within the social hierarchy of a political community. But the acquisition of silver and gold also required developing what we might call an assemblage of violence – and this not only required money but also greater energy than wood or water could provide (Nef 1994; Hall and Klitgaard 2014). While Malm focuses on waterpower and textiles, our focus is squarely on iron, steel, war, colonialism, and slavery in the making of British capitalism within the international context of the desire of elites to accumulate money and maintain or aggrandize their power (Williams (1944)[1980]; Brewer 1989; Bhambra 2021). This is reflected in Ashworth's statement that British industrial development was dependent on:

> ...a policy of nurturing domestic industry behind a wall of tariffs, skill in imitating and subsequently transforming foreign (especially Asian) products, unparalleled exploitation of African slave labour, rich resources of coal, a monopoly of trade with British North America, aggressive military prowess and, not least, a relatively efficient body for the collection of inland revenues (2008: 1047).

This now leads us to the production of coke and the steam engine.

While iron was extracted from the earth, the shaping of this ubiquitous metal required heat energy. Originally, steel – an alloy of iron and carbon – could be made with charcoal – a source of energy created by heating wood with minimal oxygen. But as energy historian Vaclav Smil (1994: 150) points out, charcoal was friable and therefore, not an ideal source of heat for making pig iron or steel.[9] Though the exact date of its use is debatable, the invention of coke and smelting iron is typically attributed to the ironmaster, Abraham Darby (Flinn 1959). Coke was far superior to charcoal for blast furnaces and required evermore coal. Moreover, Newcomen's steam engine was created around the same time, creating more demand for iron and therefore coal for making coke. We can begin to see the positive feedback loops.

Though there were certainly precursors, Thomas Newcomen is largely credited with inventing the steam engine that revolutionized British capitalism. Newcomen was an ironmonger, and he had a problem to solve unrelated to the exploitation of labour: how to remove water from tin mines (Freese 2018). The steam engine soon replaced horsepower, while more metal and more coal could be extracted from the 'subterranean forest' as water was more effectively pumped from pits (Sieferle 2001). But the question remains why were more coal and metal needed in the first place? In other words, why was Britain first to industrialize? We suggest, following the work of Priya Satia (2018), that the answer was almost exclusively the construction of an assemblage of violence centered on weapons to defend property at home and expropriate land and resources abroad. As Satia responded in a forum discussing her important research:

> Certainly, the relationship between economic and military expansion is older than the eighteenth century...but the particular logistical challenges of Britain's eighteenth-century wars – fought abroad on an increasingly mass scale with firearms – triggered the Industrial Revolution. It happened in Britain because everywhere else war was not the thing transpiring abroad that stimulated industrial resourcefulness at home, but a proximate and destructive struggle. The rivalrous dynamics between the corporate partners that made up what we call the British imperial 'state' were also key. By the end of the century, Britain was the global firearms depot, supplying them to its allies against Napoleon in millions. No other European country came close (2018: 465).

[9] Moreover, as Smil notes, deforestation occurred around furnace sites, making charcoal far from ideal as a fuel source for smelting iron (1994: 150).

The quote is revealing and connects with Brewer's work on the fiscal-military state. Rather than focus on waterpower and textiles like Malm, Brewer reminds us of the apparatus of violence being constructed within Britain as it faced the outside world as a growing naval power. First, 'the changes of the late seventeenth and eighteenth centuries were concerned not with domestic regulation but with enhancing the government's ability to wage war' (Brewer 1989: preface, np). As we will discuss below, this coincided with what Dickson (1967) called a 'financial revolution' in Britain after the creation of the Bank of England in 1694. It is worth mentioning here that Malm's work makes no connection between the expansion of credit and the industrial development of war capacity – a big oversight in our view if we want to study the links between capitalism, fossil fuel energy and climate change. The second thing Brewer (1989: 23) draws our attention to is the elite focus on naval power, whose capacity tripled in size from 1680 to 1780. According to Brewer, no other European power focused on naval power as much as Britain (1989: 26). This is of crucial importance for understanding the increasing extraction of coal and metal from the earth. As Brewer notes:

> The total fixed capital required to form a large navy was therefore enormous. In the first half of the eighteenth century the British navy boasted twenty ships of the first and second rates, approximately forty vessels of the third rate, as well as an additional 120 smaller vessels of the fourth, fifth and sixth rates. If we assume that the costs of ship construction had not risen since the late seventeenth century, then the entire fleet amounted to a capital investment of nearly £2.25 million whose replacement cost was approximately 4 percent of national income. This can be compared with the total fixed capital in the 243 mills in the West Riding woolen industry in 1800, which has been estimated at £402,651 with an average of £1657 per textile mill. The fixed capital in one of the largest sectors of the nation's most important industry was therefore a mere 18 per cent of the fixed capital required to launch the British navy (1989: 27).

Based on this observation, we are in accord with Satia's statement that 'war was the environment of economic transformation' in Britain and at the heart of the industrial revolution founded on making the material for the projection of violence and this *required* coal (2018: 465; see also Di Muzio 2015).

Furthermore, the economic historian Carol Cipolla cites Hicks' reflection that:

> [Early cotton machinery] fits better as an appendage to the evolution of the old industry than in the way it is usually presented as the beginning of the new.... Would it have been impossible, if capital could have been raised and if the regular waterpower of Lancashire had been available, for something very like it to have occurred, say in fifteenth-century Florence? There is continuity between the eighteenth-century development of Lancashire and the West Riding and the pre-Industrial Revolution world. There might have been no Crompton and Arkwright, and still there could have been an Industrial Revolution (1977: 211).[10]

There is little doubt that the production of wool and textiles were important for the rise of capitalism in Britain as a money-making enterprise (Beckert 2014). But they were far from decisive in creating an industrial society tied to near-constant warfare, the transatlantic slave trade, and the conquest of new territories – in short, empire (Vries 2013). This capitalist empire required an assemblage of violence to protect its supremacy in the world economy. This is reflected by the fact that 'by 1695 there were 140 joint stock companies with a total capital of £4.5 million, more than 80 percent had been formed in the previous seven years. By 1717, total capitalization had reached £21 million' with most of the companies aimed at overseas trade (Kindleberger and Aliber 2005: 47). In comparison, at the height

[10] Building on the work of precursors, Samuel Crompton invented the spinning mule. Richard Arkwright spearheaded the water frame.

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of Britain's textile production, it only accounted for '10 percent of Britain's GDP during the nineteenth century', employed one in six workers in manufacturing, and cotton fiber imports only yielded a total tax income of £9.8 million out of £542 million between 1793 to 1815 (Vries 2017: 131 – 2). Far from the desire to exploit labourers in a Marxist sense, the British capitalist class had the desire for profit, and this meant preparing for violent conflicts at home and abroad since power and resistance are inevitably intertwined (Gill 2008).

In fact, as Polanyi's (1957) study suggests, the paupers and poor of Britain were a problem for the elite who did not know what to do with them. As is recorded in the literature, all manner of measures were proposed to deal with this dispossessed class of people – including Bentham's Panopticon which was to be run for profit (Marx 1876 (1976): Chapter 28; Thompson 1967; Foucault 1975). If Malm's thesis is correct, the dispossessed would have been immediately exploited for capitalist profit, but in fact, this is in no way what happened historically. The paupers were a plague for the elite and largely criminalized, not a horde that could be turned into instruments of profitable exploitation. Why for instance, if the exploitation of humans is the precise origin for profit, would you expel humans from England to Australia and before 1788 to North America? Again, we remind readers that our argument is not that people were not exploited in the sense of being taken advantage of in hierarchical power relations, but that Malm's Marxist explanation is incorrect logically and historically. This brings us to our alternative account below.

III. THE BIRTH OF CARBON CAPITALISM

So far, we have demonstrated that the transition to coal and a more capitalist industrial society in Britain was tied to the accumulation of money and state investment in the means of destruction. What is missing are the links between the capitalization of the British state and the creation of the Bank of England. Like most societies who adopted gold and silver as their official money, Britain suffered from a 'dearth of money' problem primarily due to the scarcity of gold and silver (Wennerlind 2011). While a number of proposals were suggested, eventually the Crown in Parliament settled on the proposal to create a Bank of England (1694) whose issues of credit would be backed by a largely unknown horde of silver (Carruthers 1996; Davies 2002). As Wennerlind's (2011) study suggests, this created the first widely circulating credit money which acted to stimulate more state spending for war (see also Desan 2014). According to Brewer 'between 75 percent and 85 percent of annual expenditure went either on current spending on the army, navy and ordnance or to service the debts incurred to pay for earlier wars' (1989: 31). In comparison, the United States Defence Department budget for 2022 stands roughly at $US715 billion which accounts for around 10 percent of the federal budget. Moreover, O'Brien (2001) notes that Britain's *fiscal exceptionalism* was primarily from its distinctive tax system, the design of the Bank of England, and willing lenders which granted them the ability to service its national debt throughout the long eighteenth-century (1688 – 1815) of warfare and colonialism (see also Dickson 1967). From 1692 to 1815, 'Britain's debt rose from 5% to over 200% of GDP…The funds raised were not used to finance productivity or enhance infrastructures, but instead to pay for overseas wars' (Ventura and Voth 2015: 2). In fact, the largest capitalized entity in Britain was not a company but the British state (see also Di Muzio 2015: 94ff). What this means is that investors were not only investing in the power of the British state to tax the population, but more importantly, to wage war, colonize, enslave and expand and protect its commercial empire (Di Muzio 2007). And wage war, it did (see Table 3).

Table 3: British Military Campaigns from 1688 – 1815

War and Duration
Nine Years' War (1688–1697)
Williamite War (1688–1691)
King William's War (1689–1697)
War of the Spanish Succession (1701–1714)
Queen Anne's War (1702–1713)
War of the Austrian Succession (1742–1748)
King George's War (1744–1748)
1st Carnatic War (1744–1748)
Jacobite rising of 1745 (1745–1746)
Father Le Loutre's War (1749–1755)
2nd Carnatic War (1749–1754)
Seven Years' War (1756–1763)
French and Indian War (1754–1763)
3rd Carnatic War (1757–1763)
Anglo-French War (1778–1783)
American Revolutionary War (1775-1783)
French Revolutionary Wars (1792–1802)
War of the First Coalition (1792–1797)
Haitian Revolution (1793–1804)
War of the Second Coalition (1798–1802)
Irish Rebellion of 1798 (1798)
Napoleonic Wars (1803–1815)
War of the Third Coalition (1803–1806)
War of the Fourth Coalition (1806–1807)
Peninsular War (1808–1814)
War of the Fifth Coalition (1809)
War of the Sixth Coalition (1812–1814)
Hundred Days (1815)

As Brewer notes, 'after 1688 the scope of British military involvement changed radically. Britain was at war more frequently and for longer periods of time, deploying armies and navies of unprecedented size' (1989: 22). This would have been impossible without the extraction of coal, the production of iron and steel and a bank willing to extend the government of the day credit based on its sovereign power to tax its population. As Marx suggested '…capital comes dripping from head to toe, from every pore, with blood and dirt' - to which he should have added war (Marx 1867(1976): 926)[11].

[11] https://en.wikipedia.org/wiki/List_of_wars_involving_England

Another blind spot we find in Malm's analysis is his theorization of energy. Malm, like Marx, largely treats energy as a swappable auxiliary in the capitalist mode of production (Alam 2009).[12] This is why Malm (2016: Chapter 15) has little problem in arguing that capitalism started with the waterwheel and why contemporary capitalism could function with renewable energy. Yet, most scholars argue that renewable energy cannot sustain the current energy-intensive world economy and its forms of social reproduction (Zehner 2012; Friedrichs 2013; Di Muzio 2015; Trainer 2019; Dow 2022). Another issue is his distinction between thermal and mechanical energy and their roles in the economy and society, which is very similar to Marx's problematic separation between 'productive' and 'non-productive labour'. Here, mechanical energy and productive labour is seen as the primary source of capitalist profit and non-productive labour exists outside of capitalist social relations (generally the household). This is seen in how Malm's (2016) critique of Wrigley's (2010) thesis downplays the emergence of coal becoming embedded in everyday life. Wrigley argues that England's energy transformation was the result of its ability to utilize coal throughout the economy and society allowing it to out-produce its ecological constraints. On the other hand, Malm paints a narrative that British supremacy in the world economy and the origins of fossil capitalism is anchored only when capitalist owners deployed coal based mechanical energy in the factory. Simply put, for Malm, the birth of the fossil economy is the fusion of coal with industrialism, not when coal or fossil fuels also becomes inseparable from everyday life and financialization. This, once again, conflates capitalism with industrialism but more importantly most of the world's production of CO_2 comes from fossil fuels producing electricity, heat, and transportation at 73.2%, not from industrial production which accounts for 24.2% (Ritchie, Roser, and Rosado 2020). As a result, if we want to limit the looming climate emergency, we need to decarbonize much more than the factory-floor.

In our view, we see Britain as the first country to link the accumulation of money with the monetization of energy as Britain came to use coal as its primary source of energy for war, colonization and the enslavement of Africans among other things. As Peter Vries (2013: 292) reminds us 'the amount of labor power that became available to Great Britain thanks to the introduction of steam power' in 'labor-equivalents of adult male laborers' increased from 17 million in 1840 to 411 million by 1896 or 11.7 invisible steam servants for every 1 inhabitant of Great Britain. Yet, we must also keep in mind that Britain's ability to service its debt was also critical for maintaining its global empire. Consequently, capitalization, debt, violence, and energy became the central drivers of Britain's economic growth as Britain established a debt-based monetary system (Vries 2013; Hall and Klitgaard 2014; Di Muzio and Robbins 2016). Here it is good to keep in mind that the only way to expand economic growth is through the 'destruction, despoliation, and commodification of the natural world of limited and finite resources' (Di Muzio and Robbins 2016: 11). Intentionally or not, the British Empire gave birth to carbon capitalism, which is a world order and global political economy that has locked most of humanity into a vicious cycle of path dependency whereby production and social reproduction requires evermore fossil fuels, even in the age of climate change and the looming catastrophic threats and events that could follow. This path dependency reinforces how global energy consumption, carbon emissions, financial power and inequality are intertwined, as seen in how countries and people who have large fortunes consume far more energy than those countries and people who do not. At present, this seems unlikely to change (Kenner 2019; Ritchie, Rosado, and Roser 2020; Dow 2022).

[12] Marx clearly states: 'Raw material may either form the principal substance of a product, or it may enter into its formation only as an accessory. An accessory may be consumed by the instruments of labour, as coal under a boiler, oil by a wheel, hay by draft-horses, or it may be mixed with the raw material in order to produce some modification thereof' (1887: 127).

IV. CONCLUSION

In this article we have argued that carbon capitalism was born over three centuries ago, but not specifically to subordinate and exploit waged labour as Malm's Marxist account of a 'fossil economy' implies. In the end, if humanity wants to prevent the looming climate emergency Malm's treatise provides crucial historical insight of how carbon energy accelerated industrialism. But to better understand the complexities and relationships between climate change, the capitalist world economy, and social reproduction, we need more in-depth analysis of how and why the carbonization of everyday life continues and even expands. Therefore, we need to start focusing more on capitalism and current forms of social reproduction that prevent decarbonization and reinforce most of humanity's (although extremely unequally) carbon energy path dependencies (Newell 2021). More fundamentally both global political and economic elites continue to tether geopolitical power, finance, and economic growth to the production and consumption of fossil fuels, and this has made the world order fall to a standstill at the crossroads of possible futures (Dow 2022; Lucas 2022). This is why we have stressed that more factors were at work in the development of a coal-fired British imperial capitalism – specifically, the timber problem, the construction of an assemblage of violence using coal and coke to further capitalist accumulation, the financial revolution and the capitalization of the state's power to tax the population and wage war abroad. In sum, we are currently witnessing a global power struggle between social forces of right, center, and left in how to solve the looming climate crisis which is rapidly deteriorating democracies across the globe. This struggle over the future of energy is rather reflective of Timothy Mitchell's thesis especially when he stated '[f]ossil fuels helped create both the possibility of modern democracy and its limits (2011: 1).' In the coming years ahead, those limits might become more pronounced.

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