

# Escaping Malthus: a comparative look at Japan and the ‘Great Divergence’

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## Abstract

*The causes and consequences of the Industrial Revolution have led to a great deal of scholarship and debate within the field of economic history, from efforts to understand the internal dynamics of England and Europe to more recent revisionist literature that has sought to expand the debate by looking to Asia. This has enlivened and broadened the ‘Great Divergence’ debate through examining, by way of ecological factors, not only why China did not industrialize but also why England took a different path from that of China. This article expands the argument by looking at Japan, with a focus on coal mining as a foundation for escaping Malthusian constraints. As such, it will assess the extent of Malthusian pressure in pre-modern Japan and the importance of coal mining in alleviating these pressures relative to conditions in England and China.*

**Keywords** China, coal, ‘Great Divergence’, industrialization, Japan, Malthusian pressure

In recent years, the topic of the ‘Great Divergence’ has become a major debate within the field of economic history. While historians have long pondered the causes and consequences of industrialization, the publication of Kenneth Pomeranz’s *The Great Divergence* in 2000 has enlivened the debate and broadened the scope to look beyond Europe to Asia.<sup>1</sup> Since then, the ‘Great Divergence’ debate has been taken up by numerous scholars who have sought to look not only at China but also to other parts of Asia in an effort to explain what allowed western Europe to pull away from the rest of the world.

Although China still commands a great deal of attention within ‘Great Divergence’ scholarship, recent contributions by Prasannan Parthasarathi, Roman Studer, and Giorgio Riello and Tirthankar Roy have introduced India into the discourse,<sup>2</sup> while research by Jean-Pascal

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1 Kenneth Pomeranz, *The Great Divergence: China, Europe, and the making of the modern world economy*, Princeton, NJ: Princeton University Press, 2000.

2 Prasannan Parthasarathi, *Why Europe grew rich and Asia did not*, Cambridge: Cambridge University Press, 2011; Roman Studer, ‘India and the Great Divergence: assessing the efficiency of grain markets in eighteenth- and nineteenth-century India’, *Journal of Economic History*, 68, 2, 2008, pp. 393–437; Giorgio Riello and Tirthankar Roy, eds., *How India clothed the world: the world of South Asian textiles, 1500–1859*, Leiden: Brill, 2009.

Bassino *et al.*, Kaoru Sugihara, and Osamu Saito has done much to bring Japan into the debate.<sup>3</sup> Works such as these certainly mark a welcome addition to the extant literature as well as questioning, pushing, and even rejecting the original argument of Pomeranz, Frank,<sup>4</sup> and others regarding the relative standard of living and economic trajectory of Eurasia in the pre-modern and early modern periods. In the context of Japan, there has been considerable debate regarding both the quality of life and resource pressure in the pre-modern era, but a great deal of research remains to be done in order truly to establish Japan within the ‘Great Divergence’ debate.

Pomeranz points to the use of coal as having been essential to the alleviation of Malthusian land and resource pressures in early modern England. This raises the question of Japan, which, despite generally being perceived as resource-poor, had significant deposits of coal as well as a nascent mining sector, not only in coal but also in silver and copper. In addition, Japan appears to have been at least as, if not more, subject to the Malthusian idea that population growth eventually outstrips resource availability, thus leading to crisis, than either England or China. At the same time, Japan was the only country outside Europe to industrialize before the First World War. If the exploitation of coal helped to make the difference in England, did it play a similar role in Japan? I argue that, although Japanese (unlike Chinese) mining survived the pre-industrial period, coal mining in the Tokugawa period was not directly linked to Malthusian pressures, and that the pressures of an imbalance between an increasing population and dwindling resources were ultimately dealt with in other ways. Nonetheless, the survival of an indigenous mining industry may have helped smooth and expedite Japan’s transition to modernity.<sup>5</sup>

It must be noted that, although this article takes up Pomeranz’s argument regarding the importance of coal and colonies in laying the foundations of the ‘Great Divergence’, this view has been contested by scholars such as P. H. H. Vries and Klas Rönnbäck.<sup>6</sup> Vries correctly points out that coal alone is not sufficient, but needs to be harnessed and exploited. Rönnbäck, meanwhile, argues that Britain’s traditional trading partners in the Baltic could have supplied demand inputs just as well as the Americas, though the Baltics could not provide specialized raw goods such as cotton. Both of these are valid critiques. Nonetheless, the importance of coal availability and accessibility in contexts outside England and China warrants closer attention insofar as the use of coal is accepted as having been at least one significant factor in the divergent trajectories of early modern economies.

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3 See, for example, Kaoru Sugihara, ‘The east Asian path of economic development’, in Giovanni Arrighi, Takeshi Iamashita, and Mark Selden, eds., *The resurgence of east Asia: 500, 150 and 50 year perspectives*, London: Routledge, 2003, pp. 78–123; Osamu Saito, ‘Pre-modern economic growth revisited: Japan and the west’, LSE Working Paper no. 16/05, June 2005, <http://www.lse.ac.uk/economichistory/research/gehn/gehnpdf/workingpaper16-os.pdf> (consulted 15 July 2014); Osamu Saito, ‘An industrious revolution in an East Asian market economy? Tokugawa Japan and implications for the Great Divergence’, *Australian Economic History Review*, 50, 3, 2010; Jean-Pascal Bassino *et al.*, ‘Japan and the Great Divergence, 725–1890’, September 2012, [http://ahes.ier.hit-u.ac.jp/ahec\\_tokyo/papers/S3A-3\\_Bassino\\_et\\_al.pdf](http://ahes.ier.hit-u.ac.jp/ahec_tokyo/papers/S3A-3_Bassino_et_al.pdf) (consulted 15 July 2014).

4 Andre Gunder Frank, *ReOrient: global economy in the Asian age*, Berkeley, CA: University of California Press, 1998.

5 Some of the material here has been drawn from my MA thesis, ‘At the edges of the Pacific: what the California School means for Japan’, University of Vienna, 2010.

6 P. H. H. Vries, ‘Are coal and colonies really crucial? Kenneth Pomeranz and the Great Divergence’, *Journal of World History*, 12, 2, 2001, pp. 407–46; Klas Rönnbäck, ‘New and old peripheries: Britain, the Baltic, and the Americas in the Great Divergence’, *Journal of Global History*, 5, 3, 2012, pp. 373–94.

To date, discussions of the 'Great Divergence' have been largely generated by Asian specialists using Asian-language sources. However, as this article demonstrates, the availability of economic and demographic data, together with abundant material in Western languages, does allow for meaningful research and insightful analysis of developments in Japan in a comparative context.

## Japanese population density

In assessing the severity of Malthusian pressures in pre-industrial Japan, it is instructive to look first at the demographic make-up of the country. In most societies, accurate population numbers are difficult to ascertain for pre-modern times, and calculations generally remain estimates based upon the available data. In the case of Japan, territorial lords began to make great efforts at the end of the sixteenth century to determine the population figures for their respective regions.<sup>7</sup> Although these are useful for constructing national figures, they are not entirely unproblematic. Early surveys did not distinguish between households and individuals. Furthermore, these population registers focused initially on young, able-bodied men, with the purpose of locating and requisitioning labour, which the subjects of the census naturally sought to evade.<sup>8</sup> Therefore, the conflicting interests – the lords' attempts to locate potential labour and the subjects' attempts to evade the same – mean that the numbers from these population registers are not entirely reliable. Additionally, it seems highly likely that women were under-counted in these early population registers.

Nevertheless, despite inherent and unavoidable inaccuracies, it is still possible to make reasonable population projections for Tokugawa Japan (1603–1868). Various economists and historians have used population registers and estimated rice yields to generate plausible demographic numbers for Japan in the early modern period. The most widely accepted estimate of 18 million people in the early seventeenth century, proposed by Togo Yoshida, was derived from projecting the Tempo period national rice yield of 30 million *koku* (with one *koku* being equal to 180 litres or 5 bushels) back in time.<sup>9</sup> This figure corresponds roughly with a more recent estimate given by Bassino *et al.* (based on calculations from Osamu Saito), who give a figure of 17 million in 1600, and show that the seventeenth century was a period of rapid population growth in Japan.<sup>10</sup> Scholarly estimates show marked variations, however. For example, Conrad Totman puts the population at around 12 million people for this same period of time,<sup>11</sup> while Akira Hayami and Hiroshi Kito come to an estimate of around 10 million people, based on crop yield ratios derived from the Taiko land survey of the late sixteenth century.<sup>12</sup> These figures demonstrate the difficulty of

7 Akira Hayami and Hiroshi Kitô, 'Demography and living standards', in Akira Hayami, Osamu Saitô, and Ronald P. Toby, eds., *The economic history of Japan, 1600–1990, vol. 1: emergence of economic society in Japan, 1600–1859*, Oxford: Oxford University Press, 2004, p. 215.

8 *Ibid.*, p. 216.

9 Togo Yoshida, *Ishinshi hakko (Eight lectures on the history of the Meiji restoration)*, Tokyo: Fuzanbo, 1910, p. 25.

10 Bassino *et al.*, 'Japan', p. 24.

11 Conrad Totman, *Early modern Japan*, Berkeley, CA: University of California Press, 1995, p. 250.

12 Hayami and Kitô, 'Demography', p. 217.

determining precise population numbers, given that the variance between the lowest estimate and highest estimate is a staggering 80%. Nonetheless, by taking both the high and low estimates, the range of population growth can still provide valuable insight into demographic changes in pre-modern Japan.

Official figures from the first national population survey conducted by the Tokugawa shogunate in 1721 give a population of commoners of around 26 million – thus excluding some estimated 2 to 5 million court nobles, *samurai*, and their servants.<sup>13</sup> Although the pre-1721 numbers vary widely, it would seem that in the 120 years since 1600 the Japanese population increased by anywhere from 1.4 times to 2.6 times (bearing in mind that these figures do not account for the entire population). At the very least, the population probably increased by a minimum of 1.55 times. In contrast to this, the population of England in the same period grew from an estimated 4.1 million in 1601 to an estimated 5.3 million in 1721, or an increase of about 1.3 times.<sup>14</sup> During this period, then, it appears that the Japanese population was growing at a greater average rate than the English population, an indication both that resources were not yet exhausted and also that Japan was approaching her capacity at greater speed.

When looking at comparative population figures and their Malthusian implications, it is important to consider land area as well as arable land relative to the population. Japan has a total area of 377,915 square kilometres, including Hokkaido. However, Hokkaido was sparsely populated, with less than one person per square kilometre in 1750.<sup>15</sup> Thus, if we exclude Hokkaido, the total area drops to about 282,402 square kilometres, supporting a population of some 26 million in 1721, or a population density of about 92 people per square kilometre. This is again a conservative estimate, given the limitations of the 1721 census. Even including the large land mass of Hokkaido, the population density would still be 69 people per square kilometre. In addition, Japan is quite mountainous, meaning that not all of this land would have been cultivable, or even habitable. Of the total land area (including Hokkaido), 16% is considered cultivable today.<sup>16</sup> A calculation based on the contemporary figure for Japan's total area, with the exclusion of Hokkaido, would give an arable land area of 45,184 square kilometres. However, it is relevant to note that large-scale land reclamation projects were carried out throughout the Tokugawa period, such that both the overall amount of land and the amount of arable land would have been less in the eighteenth century than it is today. This may account for Bassino *et al.*'s slightly lower estimate of 37,734 square kilometres of arable land in 1720.<sup>17</sup>

Keeping in mind the sparse settlement of Hokkaido, as well as the fact that it was settled by the Ainu and not officially part of Japan at this time, it becomes clear that Japan was supporting a fairly large population on a relatively small amount of land. By comparison, England in 1721 had a population of some 5.3 million living on a land area of 130,000

13 Totman, *Early modern Japan*, p. 251.

14 Edward Wrigley and R. S. Schofield, *The population history of England 1541–1871: a reconstruction*, Cambridge: Cambridge University Press, 1981, p. 528.

15 Irene Taeuber, *The population of Japan*, Princeton, NJ: Princeton University Press, 1958, p. 22.

16 *Ibid.*, p. 22.

17 Bassino *et al.*, 'Japan', p. 25. Figures given in that paper are computed in *cho* (see n. 45 below for an explanation of this unit).

square kilometres, yielding a population density of about 40 people per square kilometre.<sup>18</sup> For the sake of argument, we will assume that England has the same amount of arable land as Japan, though a cursory knowledge of geography will reveal that it certainly has more. In any case, it seems that Japan had more than twice the population density of England in 1721, and correspondingly greater Malthusian pressures.

To some extent, the Japanese population trend parallels that seen in China. Population estimates for China vary, but one estimate has the figure rising from about 125 million in 1500 to 270 million in 1750, and to 345 million in 1800.<sup>19</sup> These estimates are quite high when compared to official figures, which record 84 million people in 1491, 180 million people in 1750, and 350 million people in 1808. However, as Lavelly and Bin Wong point out, these official figures may also have been influenced by substantial variations in the state's ability to count population.<sup>20</sup> Although these numbers imply a significantly higher growth rate in China during the pre-modern era than in either Japan or England, the time frame is also much broader. Figures from the seventeenth and eighteenth centuries show that the growth rate of the Chinese population was roughly comparable to growth rates found in Japan, the difference, of course, being that the Japanese population stagnated after 1721 whereas the Chinese population, despite some fluctuations, generally continued to grow and expand.

Though reliable figures for arable land and population density in China are difficult to find, comparing the population figures for both China and Japan in the eighteenth century indicates that China's population was about ten times larger than Japan's; the arable land mass of China during the Qing Dynasty was certainly larger than this, from which we can infer that, although China had a large population, it was in all probability not as dense as the population of Japan on aggregate. This conclusion is supported by James Nakamura and Matao Miyamoto, who calculated that Qing China had a population density of only 40 per square kilometre, and about seventeen times more arable land than Japan.<sup>21</sup> This puts China on a par with England, though these aggregate figures obscure the distribution of the relative densities.

An additional constraint on relieving Malthusian pressures in Japan was the overwhelming lack of migration possibilities. The natural geography along with the seclusion policy preventing people from leaving Japan, which was introduced between 1634 and 1639 and lasted until 1853, meant that there were fewer options than elsewhere in terms of reducing high population densities. To the extent that migration to new lands existed, it was towards the northern and southern reaches of the realm: that is, Hokkaido in the north, and the Ryukyu archipelago (Okinawa) in the south. However, this migration was marginal, and only really began to develop after programmes to promote both settlement (especially of *ex-samurai*) and land reclamation were initiated by the Meiji leadership in the second half of the nineteenth century. Even so, the Japanese population on Hokkaido increased from only

18 Wrigley and Schofield, *Population history*, p. 577.

19 Frank, *ReOrient*, p. 109.

20 William Lavelly and R. Bin Wong, 'Revising the Malthusian narrative: the comparative study of population dynamics in late imperial China', *Journal of Asian Studies*, 57, 3, 1998, pp. 717, 738.

21 James Nakamura and Matao Miyamoto, 'Social structure and population change: a comparative study of Tokugawa Japan and Ch'ing China', *Economic Development and Cultural Change*, 30, 2, 1982, p. 235.

60,000 in 1850 to 1.8 million in 1913, thus never accounting for more than a small proportion of the population, despite the relative abundance of available land.<sup>22</sup> Compared to Hokkaido, the formal annexation of the Ryukyu island chain came somewhat later, in 1879, but these islands, despite nominal independence, had long been under the effective governance of the Japanese feudal domain of Satsuma, and had also seen earlier influxes of Japanese settlers.<sup>23</sup> These early movements were mostly labour migrations to peripheral areas that to some extent may have already been considered 'Japanese', or at least within the Japanese sphere of influence, and they never accounted for any significant portion of the population.

In general, social structures in Tokugawa Japan were quite rigid, with numerous edicts binding peasants to the land and limiting their movements, though this appears to have been directed more at maintaining the family structure as the basic tax unit than necessarily at limiting the movement of individuals.<sup>24</sup> Indeed, Akira Hayami has shown that, at least in some regions of Japan, there were substantial outflows of people from the village to the city in the latter half of the Tokugawa period, an indication that movement could not have been so strictly controlled.<sup>25</sup> It is worth noting, however, that these migrations were intended to be temporary and did not represent wholesale movements to new lands. On the contrary, they represented movement towards urban centres rather than to open lands, and therefore would not have eased Malthusian pressures.

While this helps to explain the relative lack of expansion into the frontiers, Nakamura and Miyamoto have shown that certain social structures such as the *ie* (most closely translated as the household and the structure responsible for decision-making in Japanese society) created further disincentives for migration in Japan. Though a full treatment of the argument is not possible here, the hereditary hierarchical nature of the *ie* system, coupled with a non-partible inheritance system, created incentives to limit membership in the *ie*, while also discouraging migration, because it was seen as a loss to the domain.<sup>26</sup> This means that, rather than encouraging settlement at the frontiers, and thereby expanding the land base to reduce resource pressure, Japan may have focused instead on population control as a way to break out of the Malthusian cycle. This may often have taken the form of infanticide during the Tokugawa era, which G. William Skinner has argued was used 'to stop childbearing after the couple's family-size objectives had been attained'.<sup>27</sup> Although there is considerable debate about the prevalence of infanticide as an effective form of family planning, recent scholarship, including an extensive treatment of eastern Japan by Fabian Drixler, tends to agree that infanticide was in fact common and widespread, at least in certain regions of the country.

22 Totman, *A history of Japan*, Malden, MA: Blackwell Publishers, 2000, p. 328.

23 George Kerr, *Okinawa: the history of an island people*, Boston, MA: Tuttle Publishing, 2000, p. 63.

24 Osamu Saito, 'Land, labour and market forces in Tokugawa Japan', *Continuity and Change*, 24, 1, 2009, pp. 184–5.

25 Akira Hayami, *The historical demography of pre-modern Japan*, Tokyo: University of Tokyo Press, 2001, p. 157.

26 Nakamura and Miyamoto, 'Social structure', p. 258.

27 G. William Skinner, 'Conjugal power in Tokugawa Japanese families: a matter of life or death', in Barbara D. Miller, ed., *Sex and gender hierarchies*, Cambridge: Cambridge University Press, 1993, p. 253.

In any case, there were strict regulations against permanent movement out of villages, which, in addition to the disincentives of the social structure, severely limited the movement of the majority of the population.<sup>28</sup> Individuals may have moved on a temporary basis, but large-scale permanent relocations to open lands did not occur. Added to this was the fact that the Tokugawa policy of relative isolation would have made it impossible to mitigate land or resource scarcity through a programme of colonial expansion in the manner of Britain and other western European countries. As such, population control methods such as infanticide may have been necessary to stabilize population growth.<sup>29</sup>

In contrast to Japanese restrictions on migration, the Chinese state actively supported the establishment of settlements on newly cleared frontier and mountain lands. This not only served to increase the tax base but also contributed to 'building up a frontier against external enemy encroachment and providing greater effective manpower against invasions'.<sup>30</sup> Lavelly and Bin Wong also point out that, while state priorities fluctuated over time, the Chinese state generally encouraged expanded agriculture and 'state-sponsored schemes supported the migration of many millions to newly opened land'.<sup>31</sup> The expansiveness of the Chinese realm, as compared to the geographical boundaries of England and Japan as island nations, would have led to very different techniques in ensuring border security, such that populating the frontier lands would have been far more relevant and crucial for China than either England or Japan. Unlike Japan, however, England could and did engage in colonial expansion, which provided not only a potential outlet for population pressure but also access to new raw materials and resources. Japan did later embark on her own expansionist course, ostensibly to acquire resources and relieve population pressures, but, as Yasukichi Yasuba points out, it was military expansion and a shift towards heavy industry that created artificial resource shortages and overpopulation, rather than the other way around.<sup>32</sup> Certainly, the claim that expansionism was necessary in order to alleviate pressures and secure natural resources would prove to be both politically and militarily useful for Japan; the economic and demographic rationale remains far more murky.

Overall, in terms of easing land and resource pressures, England, China, and Japan all employed different strategies as rational responses within prevailing geographic, political, and social parameters. England did not have much room for territorial expansion, but did undertake a large colonial project, which brought not only more land but also more resources under British control. China, in contrast, engaged in territorial expansion along its frontier regions, thus allowing for some relief to population density as well as securing the borders, but probably having a less positive effect on resource availability than in England, given the fact that movement to the frontiers usually meant movement to less fertile lands.

28 *Ibid.*, p. 259.

29 For more detailed discussion, see Thomas C. Smith, *Nakahara: family farming and population in a Japanese village, 1717–1830*, Stanford, CA: Stanford University Press, 1977, ch. 5; Fabian Drixler, *Mabiki: infanticide and population growth in eastern Japan, 1660–1950*, Berkeley, CA: University of California Press, 2013.

30 Skinner, 'Conjugal power', p. 259.

31 Lavelly and Bin Wong, 'Revising the Malthusian narrative', p. 725.

32 Yasukichi Yasuba, 'Did Japan ever suffer from a shortage of natural resources before World War II?', *Journal of Economic History*, 56, 3, 1996, pp. 543–4.

Tokugawa Japan could undertake neither territorial expansion nor colonial expansion to deal with population and resource pressure. Rather, it seems to have developed certain social institutions and family-planning strategies to control population size and stabilize resource pressures. There is evidence to suggest that infanticide was also practised in China as a method of family planning, and this may help to explain a slowdown in population growth in the nineteenth century.<sup>33</sup> However, the Chinese population never stabilized in the manner seen in Tokugawa Japan. Despite some incentive to use infanticide to limit population growth or to control for sex, China certainly tended more towards population growth and migration than did Japan. Britain, in contrast, had colonies both to provide resources and to absorb migrant populations. Japan later used her own colonies in Asia to similar effect, but this was arguably more to sustain industrialization than to initiate it. As a result, it appears that in the pre-modern and early modern periods, Japan had less opportunity to expand her land or resource base than either England or China, except potentially through greater use of subterranean resources such as coal.

Given the high population density of Japan in the early eighteenth century, even according to low estimates, along with the lack of labour mobility or migration, it will hardly come as a surprise that the population began to stagnate in subsequent decades, showing signs of overpopulation and land exhaustion. According to census results, the Japanese population remained stable in the 120-year period following 1721, rising only from an estimated 26,065,425 people in 1721 to around 26,907,625 people in 1846.<sup>34</sup> This represents almost zero growth in a period of relative peace and political stability. Can we conclude, therefore, that Japan had reached a Malthusian ceiling by the early eighteenth century?

## Population stagnation and agriculture

Conventional wisdom would indicate that century-long population stagnation implies some land capacity having been reached, given the agricultural methods and technology available at the time. It was also around the first half of the eighteenth century that peasant unrest and uprisings began to become more frequent in Japan, another indication that land and resources were probably scarce. As a result, an increasing number of laws and edicts regarding peasant behaviour began to be issued by the Tokugawa shogunate, with the first law specifically concerning peasant uprisings and the use of five-family groups (*gonin gumi*) to control these uprisings being issued in 1721.<sup>35</sup> In the subsequent decades until 1839, at least ten more laws specifically relating to the problem of peasant uprisings were issued, with increasingly strict regulations and severe punishments.<sup>36</sup> The causes of these uprisings were numerous, resulting not only from peasant discontent with shogunate policies and the maladministration of fiefs but also from increasingly heavy tax burdens and demands

33 Lavelly and Bin Wong, 'Revising the Malthusian narrative', p. 738.

34 Eijiro Honjo, *The social and economic history of Japan*, Kyoto: Institute for Research in Economic History of Japan, 1935, p. 154.

35 Hugh Borton, *Peasant uprisings in Japan of the Tokugawa period*, New York: Paragon Book Reprint Corporation, 1968, p. 35.

36 *Ibid.*, pp. 35–6.



on the part of the shogunate and domainal officials for the extension of the area of cultivated land.<sup>37</sup>

Although an immediate conclusion might be that these instances of peasant unrest had a direct correlation to decreasing resource availability, Nakane, Ōishi, and Totman argue that many uprisings were in fact demands for social reforms that would eliminate extreme disparities in wealth.<sup>38</sup> Osamu Saito contests this view of growing economic differences, claiming that Japan's pre-modern growth 'was not associated with increased income inequality among the social classes', though he immediately follows this with the admission that 'there was the rise of a rural elite, wealthy farmer-landlords who were sometimes rural entrepreneurs as well'.<sup>39</sup> While Saito contends that the emergence of this elite rural class actually helped to narrow the urban-rural divide over time, and thus led to an overall decrease in income inequality, this would not have been perceived by rural dwellers at the time, and may very well have led to riots and unrest not directly related to Malthusian pressures.

In addition, the eighteenth century saw increasing famines, which may also be regarded as a Malthusian check and an indication that the land was nearing exhaustion. However, Kozo Yamamura has convincingly shown that the official number of deaths recorded as a result of the major Tokugawa famines was probably exaggerated by the affected domains, in an effort to minimize the exactions imposed on them by the shogunate.<sup>40</sup> By inflating death rates, these domains may have hoped to signal exaggerated distress in order to lessen taxes and other services normally required of them. To what extent this was done is unclear, but it does indicate that official figures may not be entirely reliable. Saito also points out that, while population stagnation may seem to have been a result of Malthusian checks, such as famine and crop failure, it was not necessarily through increased mortality that population growth declined, but through reduced fertility.<sup>41</sup> As already noted, infanticide was practised throughout the realm. Concurrently, it has been shown that through large-scale land-reclamation projects the amount of land more or less kept pace with the increasing population until approximately 1720, when both began to tail off.<sup>42</sup>

Up to this point there had been great improvements in agricultural techniques, including increased output through the expansion of both dry-field and paddy cropping as well as the use of fertilizers, which allowed farmers to double and triple crop yields.<sup>43</sup> In addition to these improvements, there were large strides made in water management, which was a vital development for effective and efficient use of reclaimed land. The construction of levees,

37 *Ibid.*, p. 22.

38 Chie Nakane, Shinzaburo Ōishi, and Conrad Totman, *Tokugawa Japan: The social and economic antecedents of modern Japan*, Tokyo: University of Tokyo Press, 1991, p. 59.

39 Saito, 'Pre-modern economic growth', p. 40.

40 Kozo Yamamura, 'Toward a reexamination of the economic history of Tokugawa Japan, 1600–1867', *Journal of Economic History*, 33, 3, 1973, p. 545.

41 Saito, 'Pre-modern economic growth', p. 24.

42 Matao Miyamoto, 'Quantitative aspects of Tokugawa economy', in Hayami, Saitō, and Toby, *Economic history*, p. 38.

43 Conrad Totman, *Pre-industrial Korea and Japan in environmental perspective*, Leiden: Brill, 2004, p. 127.

dams, and canals not only was essential in preventing rivers from flooding but also enabled peasants living near the middle and lower reaches of large rivers to engage in farming, and helped to draw water from swamplands to previously unproductive land and foothills.<sup>44</sup> This had a large impact on both the amount of available arable land and its agricultural efficiency. This was undeniably a period of rapid land expansion, with arable land increasing from an estimated 2,064,657 *cho*<sup>45</sup> in 1600 to 2,970,780 *cho* in 1730, and to a further 3,234,000 *cho* by the beginning of the Meiji period.<sup>46</sup> While this was impressive, it coincided with population growth at an annual average of 0.61%–0.96% until around 1720, which is surprisingly high for a pre-modern society.<sup>47</sup> After this, as already mentioned, both the population growth rate and the rate at which arable land was increasing began to decline.

Japan managed to support its large population through various innovations, including fertilizing techniques and farm-tool technology. One of the early fertilizing techniques involved the use of fishmeal and sardines, which supplemented mulch and earlier materials.<sup>48</sup> The use of fishmeal as fertilizer was important for several reasons. It was not directly related to the geographical land boundaries of the country, and therefore represents, to a small degree, an escape from traditional land-bound fertilizers. It also spurred the fishing industry and promoted investment in larger fishing fleets and nets.<sup>49</sup> Though sardines were also caught for regular consumption, farms consumed sardines in much larger numbers than did urban consumers, which led to the establishment of sardine guilds, which in turn cooperated in helping to increase the size of sardine hauls.<sup>50</sup> While this does provide one example of Japan being able to go beyond its land base to improve agricultural output, the use of fishmeal would have been fairly marginal compared to other fertilizers, not to mention that it did not actually present an escape, since fish stocks would eventually be depleted and nothing changed in the prevailing mode of production.

Developments in farm-tool technology included the invention of more effective hoes and sickles, such as the Bichu hoe, which permitted deeper tilling and was instrumental in the initial stages of soil preparation.<sup>51</sup> In conjunction with new farming tools, there was an expansion in iron mining, which drew on Chinese smelting techniques to provide the quantity and quality of the metal needed in order to make new tools.<sup>52</sup> Although these tools may seem quite simple, the processes involved in mining the necessary metals and the extent to which they augmented farming capacity were relatively complex.

44 Chie Nakane, Shinzaburō Ōishi, and Conrad Totman, *Tokugawa Japan: the social and economic antecedents of modern Japan*, Tokyo: University of Tokyo Press, 1991, pp. 63–4.

45 A *cho* is a Japanese unit of area approximately equivalent to 1 hectare (in fact, 0.009917 square kilometres), which is equivalent to 2.47 acres.

46 Miyamoto, 'Quantitative aspects', p. 39.

47 *Ibid.*, p. 41.

48 Michael Smitka, ed., *The Japanese economy in the Tokugawa era, 1600–1868*, Garland Publishing, 1998, p. 66.

49 Totman, *Pre-industrial Korea and Japan*, p. 147.

50 Smitka, *Japanese economy*, p. 66.

51 Nakane, Ōishi, and Totman, *Tokugawa Japan*, p. 69.

52 Totman, *Pre-industrial Korea and Japan*, p. 130.

Another important innovation was the so-called *semba-koki*, considered the only important mechanical innovation in farming during the Tokugawa period.<sup>53</sup> This new thresher consisted of a wooden frame with protruding teeth through which rice or wheat stalks were drawn to strip away the grain. It improved significantly upon prior methods, which consisted of two bamboo sticks across which the stalks were drawn.<sup>54</sup> The new method was certainly more efficient, and illustrates the implementation of one type of labour-saving technology. However, even such inventions as this, while appearing to save labour through increased efficiency, often masked the end result of such an efficiency increase: though the *semba-koki* saved labour at the time of the harvest, it also made it possible for the first time to plant a winter crop immediately following the autumn harvest.<sup>55</sup> Therefore, rather than really saving labour, it merely evened out the distribution of labour throughout the year.

Indeed, Akira Hayami argues that Japanese peasants in the seventeenth and eighteenth centuries actually shifted away from ploughs and animal power, and increased the input of their own manual labour instead. Osamu Saito contests that argument, pointing out that in some regions of Japan the numbers of oxen and horses increased. Nonetheless, the end result was the same: the consequence of more animal use was 'to increase labour intensity, since ploughing, hoeing, weeding, and other supplementary tasks are interrelated'.<sup>56</sup> Whether the number of animals increased or decreased, Hayami and Saito are in agreement that Japan was becoming relatively more labour intensive, with Conrad Totman even asserting that, by 1870, Japanese agriculture had become one of the world's most intensive in terms of both labour inputs and yield per arable hectare.<sup>57</sup> This indicates not only the efficiency with which the Japanese were able to work their lands, but also an overwhelming reliance on labour inputs. Although it is generally agreed that Europe, and England specifically, had a historically more capital-intensive mode of agricultural production than Asia, Jan de Vries has shown that 'in Western Europe no less than in East Asia, agricultural production became increasingly labour-intensive over time, even though the degree of this intensity at any given time differed from one society to another'.<sup>58</sup> Thus, increasing labour intensity in agriculture may have been a general response to Malthusian pressures, corroborating the Pomeranz thesis that England may very well have followed the same path as China, had it not been for greater resource access in the form of coal and colonies.

Therefore, on the one hand we have evidence of increasing famines and peasant unrest, which might at first glance fall under the category of Malthusian checks, reflecting the growth of population beyond the ecological limits. On the other hand, figures indicate that the growth of land kept pace with the growth in population into the eighteenth century, when increasing labour inputs came to be used. It is true that this could very well indicate the

53 Thomas Carlyle Smith, *The agrarian origins of modern Japan*, Stanford, CA: Stanford University Press, 1959, p. 102.

54 Nakane, Ōishi, and Totman, *Tokugawa Japan*, p. 69.

55 Smith, *Agrarian origins*, p. 102.

56 Osamu Saito, 'Industrious revolution', p. 245.

57 Totman, *Pre-industrial Korea and Japan*, p. 145.

58 Jan de Vries, 'Industrious peasants in East and West: markets, technology, and family structure in Japanese and western European agriculture', *Australian Economic History Review*, 51, 2, 2011, pp. 109–10.

maximum capacity of both population and land having been reached, but unrest appears at least in some instances to have been the result of social and political issues, whereas actual death rates due to famine may have been much lower than was officially reported. Additionally, there is evidence that this period witnessed an increase in wages and the availability of wage labour.<sup>59</sup> Thus, despite a lack of migration or emigration, it would appear that Japan was perhaps not as Malthusian as is often claimed, and was able to deal effectively with those pressures that did exist in such a way as to maintain a stable population and possibly even improve the standard of living.

## Standard of living

The relative standard of living in China and Europe comprises a significant portion of Kenneth Pomeranz's thesis that, prior to the nineteenth century, the Chinese and the Europeans lived in a 'world of surprising resemblances'.<sup>60</sup> The main indicator normally cited for standard of living is life expectancy. Though perhaps a narrow and purely quantitative rather than qualitative measure, life-expectancy figures do, at a minimum, reflect the general ability of a society to feed itself. Pomeranz maintains that this ability was comparable in China and in Europe. Based on a study by Wrigley and Schofield, he finds a life expectancy in English villages of mid to high thirties through the eighteenth century, which climbed to forty in the nineteenth century, and then remained fairly steady until after 1871.<sup>61</sup> However, he concedes that even these figures may be too high, since there may have been an under-reporting of births and deaths in village communities. Pomeranz's figures for China are less clear, but he gives a figure for a 'relatively prosperous area' of 39.6 in the eighteenth century, which declined to 34.9 in the nineteenth century.<sup>62</sup> Which area this might be is not specified, but, while even the lower figure might still be somewhat comparable to the English figures, the decrease in life expectancy indicates a negative trajectory, at odds with the positive direction of the English numbers.

Data compiled by Lavelly and Bin Wong seem to corroborate a decline in life expectancy in China from the end of the seventeenth century to the middle of the nineteenth century, though the data is not entirely conclusive.<sup>63</sup> Despite this, Pomeranz, Lavelly, and Bin Wong all convincingly argue that China was not the poor, involuted country that it is often assumed to have been. Allen *et al.* have also persuasively argued that the standard of living for unskilled workers in major cities in China and Japan kept pace with that of central and southern Europe for most of the eighteenth century; indeed, they show that 'it was only England and the Low Countries that pulled ahead of the rest, [which] in this context includes not only Asia but also much of Europe'.<sup>64</sup>

Asia as a whole has traditionally been characterized as overwhelmingly poor with a low standard of living before industrialization, with Japan occasionally being cited as a

59 Conrad Totman, *Pre-industrial Korea and Japan*, p. 153.

60 Phrase taken from the title of Part 1 of Pomeranz, *Great Divergence*.

61 *Ibid.*, p. 36.

62 *Ibid.*, p. 37.

63 Lavelly and Bin Wong, 'Revising the Malthusian narrative', p. 721.

64 Robert Allen *et al.*, 'Wages, prices and living standards in China, 1738–1925: in comparison with Europe, Japan and India', *Economic History Review*, 64, supplement 1, 2011, pp. 30–1.

possible exception.<sup>65</sup> Hanley and Yamamura, both of whom have done extensive research on Japanese demographics, find a life expectancy of between 34.9 and 41.1 for males, and 44.9 and 55.0 for females, in two villages in Japan in the late eighteenth and early nineteenth centuries.<sup>66</sup> The timing of this study is of particular value: these estimated life expectancies come during the period of 'stasis', in which the population stagnated and Malthusian pressures supposedly mounted. However, the life expectancies for the time do not indicate that Japan was less able to feed its large population than England or China. In addition to this, Hanley has shown in the well-researched *Everyday things in Japan: the hidden legacy of material culture* that, by making optimal use of resources in the long run rather than maximum use in the short run, Japan was able to maintain a dense population on a relatively small allotment of land.<sup>67</sup> Although per capita income may have been lower than in Europe, other factors that influence the standard of living, such as hygiene and education, were comparably high in Japan.<sup>68</sup> Even Yasukichi Yasuba, who is sceptical of Hanley's data and methods, concludes that the Japanese standard of living would not have been much below that of the English before industrialization, even if per capita income appears to have been somewhat lower.<sup>69</sup>

The standard of living of the Japanese in relation to their European counterparts has also been shown to be comparable through a comprehensive analysis of food consumption in Japan by Penelope Francks. Contrary to the Western notion that rising living standards have historically corresponded to diversification away from grains and towards more meat and dairy consumption, Francks shows that

for Japanese people rice was by no means the cheapest source of carbohydrate but rather a tasty and sophisticated consumer good that embodied their modern urban identity. Being able, as a result of rising income and urban facilities, to switch to a pure white-rice diet meant having a higher standard of living, whatever it might have done to nutrition and health.<sup>70</sup>

In addition to this, sugar, tobacco, and especially tea are shown to have been increasingly consumed and to have led to a growing 'consumption cluster' of items associated with the consumption of these goods, such as the kettles, teacups, and ladles used for tea-drinking and the pipes and bowls used to smoke tobacco.<sup>71</sup> This indicates a rising standard of living and

65 Eric Jones, *The European miracle: environments, economies and geopolitics in the history of Europe and Asia*, Cambridge: Cambridge University Press, 2003.

66 Susan Hanley and Kozo Yamamura, *Economic and demographic change in preindustrial Japan, 1600–1868*, Princeton, NJ: Princeton University Press, 1977, pp. 221–2.

67 Susan Hanley, *Everyday things in pre-modern Japan: the hidden legacy of material life*, Berkeley, CA: University of California Press, 1997, p. 53.

68 Kaoru Sugihara, 'Agriculture and industrialization: the Japanese experience', in Peter Mathias and John A. Davis, eds., *Agriculture and industrialization: from the eighteenth century to the present day*, Oxford: Oxford University Press, 1996, p. 149.

69 Yasukichi Yasuba, 'Standard of living in Japan before industrialization: from what level did Japan begin? A comment', *Journal of Economic History*, 46, 1, 1986, p. 224.

70 Penelope Francks, 'Simple pleasures: food consumption in Japan and the global comparison of living standards', *Journal of Global History*, 8, 1, 2013, pp. 100, 106.

71 *Ibid.*, pp. 107–11.

increasing ability to purchase items beyond subsistence as early as the end of the Tokugawa period, even if it does not correspond to Western notions of consumption hierarchies.

Overall, therefore, it seems that Japan would have ranked favourably against both England and China in at least some measures of pre-industrial standards of living. Granted, this may not be a particularly revealing conclusion, since it is unlikely that there would have been extreme differences in wealth between any two pre-industrial countries; what it does serve to highlight, however, is that the Japanese standard of living managed to keep pace with a growing population during the Tokugawa period, which signals that this epoch in Japanese history could not have been as static and backward as it is often characterized.

In the final analysis, then, it seems that, although Japan probably had a greater population density, and fewer expansion or migration possibilities, than either China or England, there is no strong evidence to suggest that the average standard of living was appreciably worse. This indicates that Tokugawa Japan devised effective methods to cope with these pressures, methods that were necessarily domestic and limited geographically on account of the seclusion policies of the time. Social structures limiting population size, as well as population control measures such as infanticide, probably explain part of this, along with an increasing intensity of land use and agricultural production. However, resource use, particularly subterranean resources that required little land surface, may shed further light on the remarkable ability of pre-industrial Japan successfully to maintain a very large population, while possibly even improving the living standard over time.

## Resource use

The availability and use of resources can be instructive in painting a picture of the Japanese path to industrialization. Energy and resource use is one of the critical points on which writers such as Kaoru Sugihara and Kenneth Pomeranz differ. Both consider the maintenance of a remarkably high standard of living, given the extraordinary population size of China and Japan, to be an Asian miracle of sorts, but their views diverge in regard to the question of the internal dynamics of this ‘miracle’. Sugihara suggests that a basic and crucial difference between the opposite ends of Eurasia is that before the eighteenth century western Europe was already on a capital-intensive path and East Asia was on a labour-intensive path.<sup>72</sup> Osamu Saito echoes this view, claiming that ‘at the beginning of the seventeenth century Japan had already been on a labour-intensive track, so that the subsequent developmental path was very different from that of Western Europe’s’.<sup>73</sup> Pomeranz, on the other hand, argues that as late as 1750 China and Europe were surprisingly similar and, had it not been for coal and colonies, England might very well have ended up on the same labour-intensive path as China, thereby inhibiting the possibilities of modern economic growth.<sup>74</sup> As we have already seen, Japan was probably faced with even more land pressure than China or England. To what extent did it look to more efficient resource use to mitigate these problems, and how does this compare to England and China?

72 Sugihara, ‘Agriculture and industrialization’, pp. 151–2.

73 Saito, ‘Industrious revolution’, pp. 258–9.

74 Pomeranz, *Great Divergence*, p. 13.

The existence and accessibility of raw materials, most notably coal, play an integral part in Kenneth Pomeranz's explanation of the 'Great Divergence'. He paints a complicated and somewhat contradictory picture of Chinese coal mining, which appears to have been at its height in the eleventh century, but declined thereafter as a result of Mongol invasions, civil wars, floods, and plague.<sup>75</sup> Additionally, he argues that these mines were largely in the north-west of China, a fairly backward region, distant from the rich and fuel-hungry Lower Yangtze basin. The high transport costs and detachment from technical developments would have inhibited the sort of advances later made in England, where coal deposits were located near excellent water transport and near Europe's most commercially dynamic economy.<sup>76</sup>

Despite geographical disadvantages faced by China, however, Pomeranz asserts that the Chinese had long understood the basic scientific principle underlying the steam engine, such that 'Europe's advantage rested as much on geographical accident as on overall levels of technical skill and much more than on any (probably non-existent) advantage in the market efficiency of the economy as a whole'.<sup>77</sup> In essence, the argument then boils down to the location of coal mines and proximity to urbanized, fuel-hungry regions. Pomeranz drives home this point by claiming that 'Though China may have had less chance than Europe to expand construction and fuel-intensive industries, it probably did not face a much greater threat to its ability to reproduce its existing standard of living than a hypothetical Europe without the Americas would have faced; indeed, it may have been slightly better-off'.<sup>78</sup> This supposes that colonial expansion was decisive for Europe. Indeed, colonies seem to have been important for England, but the Americas did little for Spain and Portugal in the way of industrializing. Furthermore, it was China more than Japan that was able to expand its land and resource base by moving into frontier lands, and yet it was Japan that industrialized and raised its standard of living well beyond the rest of Asia.

The slow rate of industrialization in China in relation to England and Japan raises obvious questions, given that historical records show that China had knowledge of coal and iron mining long before these became important sources of energy and production in England, or anywhere else in Europe for that matter. The production of both coal and iron appear to have been at their height in the Song Period (960–1279 CE), with north China producing annually more than 114,000 tons of pig iron by 1078, or double what England would produce 700 years later.<sup>79</sup> It is relevant to note that this production was in North China, which seems to corroborate Pomeranz's view that mining centres were simply too distant from the main urban centres of the Yangtze Delta to be profitable. However, during the Northern Song Period (960–1127), the imperial capital was situated in the north at Kaifeng, which grew into an impressive urban centre, and, according to Robert Hartwell, was probably unsurpassed by any other metropolis in the world prior to the nineteenth century.<sup>80</sup> Industry grew up initially to

75 *Ibid.*, p. 62.

76 *Ibid.*, pp. 64–6.

77 *Ibid.*, p. 62.

78 *Ibid.*, p. 226.

79 John Fairbank and Merle Goldman, *China: a new history*, Cambridge, MA: Harvard University Press, 2006, p. 89.

80 Robert Hartwell, 'A cycle of economic change in imperial China: coal and iron in northeast China', *Journal of the Economic and Social History of the Orient*, 10, 1, 1967, p. 125.

meet government needs, and also as a result of large deposits of coal and iron, which could be transported over waterways fairly easily to the capital.<sup>81</sup>

The Song capital was able to grow to its formidable size largely because of the availability of fuel and heating supplies in the form of coal and timber from surrounding areas. Coal mines, discovered and opened in the second half of the eleventh century, were only 132 miles from the capital city, and connected entirely by waterways, which was a distance less than half that required for the British shipping of coal from Newcastle to London.<sup>82</sup> Traces of coal use have been found in iron artefacts from the Song and Yuan dynasties, and Donald Wagner has even found signs to indicate that coal may have been used as early as the fourth century.<sup>83</sup> Though some of this very early evidence is disputed, it is clear that coal mining, and knowledge of coal-processing as well as coal-mining techniques, existed in China at quite an early stage, and that, at least during the Northern Song period, it facilitated the growth of major conurbations in the vicinity of deposits. In fact, the extraction and use of coal was something that Marco Polo commented on in his travels to China towards the end of the thirteenth century.<sup>84</sup>

The fact that coal was known and used at such an early stage of Chinese history makes even more pressing the question of why steam power was not already discovered at this time, and why the industry had declined so dramatically by the time that England began to industrialize. The reasons for decline seem to have been manifold, including those mentioned by Pomeranz, but it was also due to the loss of the main market in Kaifeng, following a dramatic shift in the course of the Yellow River after it burst its dikes in 1194, thus severing the direct waterway connection between the mines and the metropolis.<sup>85</sup> The subsequent Mongol invasions led to further devastation and depopulation in northern China, which resulted in economic and political reorientation away from mining such that, by the Qing period, many mines had been abandoned. Indeed,

from at least the beginning of the twentieth century to the eve of the Second World War it would appear that not one ounce of metal was extracted from ores at these sites [in central Shantung and northern Kiangsu] which had yielded from 10,600 to almost 23,000 tons of iron *per annum* at the beginning of the last quarter of the eleventh century.<sup>86</sup>

The Song period also saw a marked shift in the centre of gravity of the Chinese economy. Angus Maddison argues that in the eighth century 75% of the population lived in the north and mainly produced wheat and millet, yet, by the end of the thirteenth century, 75% of the population lived south of the Yangtze in a previously lightly settled region that proved ideal

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81 Fairbank and Goldman, *China*, p. 89.

82 Hartwell, 'Cycle of economic change', p. 136.

83 Donald Wagner, 'Blast furnaces in Song-Yuan China', *East Asian Science, Technology and Medicine*, 18, 2001, pp. 50–2.

84 Marco Polo, *The travels of Marco Polo: the complete Yule–Cordier edition*, tr. Henry Yule, rev. Henri Cordier, New York, Dover Publications, Book 2, ch. 30, 'Concerning the black stones that are dug in Cathay, and are burnt for fuel', pp. 442–3.

85 Hartwell, 'Cycle of economic change', p. 149.

86 *Ibid.*, p. 148.



for rice cultivation.<sup>87</sup> David D. Zhang *et al.* show evidence for a similar trend, claiming that, since the Song period China's economic and cultural centres have moved southward to the Yangtze delta, a region which subsequently, and consistently, supported over 60% of China's population up to the twentieth century.<sup>88</sup> This demographic relocation southward probably affected the use and extraction of coal, which was found in the north. Although there are some scholars who argue that the use and production of coal continued and possibly even expanded in the Ming period, the extant data and research on coal during this period is so scant as to make this largely speculative.<sup>89</sup>

The question of why China did not develop steam technology around this time remains open and in need of further research. Pomeranz's explanation is that ventilation problems proved inadequate, in light of the fact that mines in China were shallow and much more plagued by drainage problems owing to a high groundwater level in northern Kiangsu than by anything else.<sup>90</sup> In any event, it is generally agreed that the industry was in decline by the late eighteenth century at the very latest, though many writers argue that this occurred much earlier.<sup>91</sup> It seems likely that the industry had so massively declined by the time that steam power could have been introduced from abroad that it may even have inhibited the successful transfer of technology.

To what extent can we conclude that Japan was similar to or different from China and/or England in terms of coal availability and consumption? The research and data on this topic are surprisingly scarce, so it is difficult to draw any definitive conclusions. Conrad Totman devotes a few pages to the topic of ground coal and expansion, which gives some insight into the situation, but quantitative data is scant.<sup>92</sup> However, from the research that does exist, we can determine at least to some extent the inception and development of a coal-mining industry in early modern Japan. Clearly one of the fundamental prerequisites for the construction of a coal mine is the presence of coal; indeed, Japan does have large coal deposits but these are located at the peripheral regions of the realm. Most of these deposits can be found in the southern reaches of Honshu and northern parts of Kyushu, around the prefectures of Nagasaki, Yamaguchi, and Fukuoka. Fittingly, endogenous coal mining, which germinated in the late seventeenth century, centred around these three prefectures.<sup>93</sup> Significant amounts of coal can also be found in Hokkaido. However, prior to the very end of the Tokugawa period, Hokkaido was an underdeveloped region, with a sparse population and no industry to speak of aside from fishing, which mitigated both the need for coal and the feasibility of extracting it.<sup>94</sup>

87 Angus Maddison, 'Six transformations in China: 960–2030', in D. S. P. Rao and B. Van Ark, eds., *World economic performance: past, present and future*, Cheltenham: Edward Elgar Publishing, 2013, p. 7.

88 David D. Zhang *et al.*, 'Climatic change, wars and dynastic cycles in China over the last millennium', *Climatic Change*, 76, 2006, p. 472.

89 Tim Wright, 'An economic cycle in imperial China? Revisiting Robert Hartwell on iron and coal', *Journal of the Economic and Social History of the Orient*, 50, 4, 2007, p. 415.

90 Robert Hartwell, 'Markets, technology, and the structure of enterprise in the development of the eleventh-century Chinese iron and steel industry', *Journal of Economic History*, 26, 1, 1966, p. 48.

91 Wright, 'Economic cycle', p. 415.

92 Totman, *Early modern Japan*, pp. 270–9.

93 Nisaburo Murakushi, 'Coal mining', *Developing Economies*, 17, 4, 1979, p. 461.

94 Yutaka Kasuga, 'Transfer and development of coal-mine technology in Hokkaido', United Nations University HSDP-JE series 48, United Nations University, Tokyo, 1982, p. 1.

Owing to far more favourable geography and topography than the coal deposits in Hokkaido, the mines of Kyushu, particularly the Miike and Takashima mines, developed into large-scale mining operations, around which the endogenous mining industry flourished.<sup>95</sup> These mines, though perhaps not as peripheral as those in northern China after the demographic shift towards the south, were similarly located a fair distance from the urban centres of Kyoto and Osaka, and even further from Edo (modern-day Tokyo). Historical records show that, while coal had been discovered in Miike by the fifteenth century, systematic mining there and in surrounding mines was only begun at the end of the seventeenth century, and lasted through to the twentieth century.<sup>96</sup> The size and scale of Japanese mining operations prior to industrialization were modest, but northern Kyushu established itself as a coal-mining centre in the eighteenth and nineteenth centuries.

While population growth and deforestation certainly contributed to the expansion of coal mining in Japan, the output of the mines remained small in comparison to western Europe, and especially Britain. Within Britain, the majority of mines were in England, but both Scotland and south Wales were also important coal producers. Total coal production in Japan in the 1860s is estimated to have been only about 390,000 tons,<sup>97</sup> whereas Britain in 1700 was already producing around 3 million tons per year.<sup>98</sup> This was despite Britain's smaller size and lower population density. However, Britain's scanty timber supplies probably helped to encourage greater coal use. In Japan, although increasing scarcity of timber did lead to some increased demand for coal for fuel and heating purposes, much of the mined coal, until the middle of the nineteenth century, appears to have been used as fuel in salt production along the coasts of Kyushu.<sup>99</sup> Additionally, Japan had a much greater natural timber endowment than Britain to begin with, and through successful afforestation programmes, initiated in the Tokugawa period, Japan remains largely wooded even today.<sup>100</sup> Coal mining generally remained a spare-time occupation, carried out through relatively primitive means by peasants who were free of other labour obligations.<sup>101</sup>

It therefore seems that coal could not have been fundamental to energy production in pre-industrial Japan. Timber and charcoal remained the main sources of energy for heating and cooking, with the equivalent of up to 4 million bushels being shipped to Edo by the end of the Tokugawa period.<sup>102</sup> It is true that the construction boom and growing population of the early Tokugawa period meant that timber reserves in highly urbanized areas were becoming

95 Murakushi, 'Coal mining', p. 462.

96 Yoshio Oba and Kiyomi Kodama, 'On the history of capital accumulation and technical revolution in Japanese coal mining', *Hokkai Gakuen University Collection*, 150, 2011, p. 136.

97 Shinya Sugiyama, *Japan's industrialization in the world economy, 1859–1899: export, trade, and overseas competition*, London: Bloomsbury Publishing, 2012, p. 191.

98 Emma Griffin, *A short history of the British industrial revolution*, Basingstoke: Palgrave Macmillan, 2010, pp. 109–10.

99 Oba and Kodama, 'Capital accumulation and technical revolution', p. 135.

100 Conrad Totman, 'Land-use patterns and afforestation in the Edo period', *Monumenta Nipponica*, 39, 1, 1984, p. 1.

101 Janet Hunter, ed., *Japanese women working*, New York: Routledge, 1993, p. 100.

102 Hanley, *Everyday things*, pp. 62–3.

depleted by the end of the seventeenth century.<sup>103</sup> However, although this coincided with the germination of sustained coal mining in northern Kyushu, and may have helped to spur the initial growth in coal mining, even a century later coal had not come close to replacing charcoal as a major source of fuel. One reason for this may be that, despite depletion, Japan had significantly more timber reserves than either Britain or China until the twentieth century.<sup>104</sup> This was not only due to a high natural endowment but, much more importantly, to the earlier afforestation efforts noted above. In turn, any serious Malthusian pressures could not have been solved through the relatively small amounts of coal extracted from the Kyushu mines, most of which seems to have been used locally. These pressures were probably managed through highly efficient land and resource use, effectively maximizing Smithian growth through greater factor inputs and specialization, rather than by any fundamental shift in the energy supply or mode of production.

This is not to say that coal was irrelevant. Coal mining was important for the production of salt, and became an increasingly important occupation for the people of northern Kyushu. The mining experience accumulated over generations allowed for a rapid expansion in mining once steam-powered technology had been introduced. Indeed, Japan's coal output increased to 7.5 million tons in 1900, a remarkable nineteen-fold increase in just forty years.<sup>105</sup> This was largely a result of opening more mines in Hokkaido and the introduction of modern mining technology, but it was possible in such a short period only because the fundamental structures of the industry already existed.

The establishment of an endogenous mining system was a result not only of the existence of relatively accessible coal but also of state support. This became most pronounced under the Meiji leadership of the later nineteenth century, but the industry had already existed and developed within the bounds of pre-modern technological capabilities under the Tokugawa shogunate. However, it seems unlikely that coal was used to alleviate significant fuel shortages, given the relatively small quantities mined. There is evidence that around half of the coal mined in northern Kyushu was also sold and used in local areas, rather than being shipped to the urban, fuel-hungry regions of Kanto and Kinai.<sup>106</sup> In China, in contrast, there seems to have been declining support for mining activities after the founding of the Qing dynasty in the late seventeenth century.<sup>107</sup>

Although the largest and most significant changes in the Japanese coal-mining industry came with the opening of Japanese ports in the 1850s, even the introduction of steam power and modern techniques merely augmented rather than supplanted the endogenous methods. Coal mining essentially became a compromise between old and new methods, although the existence of an endogenous industry and skilled workers greatly eased the transition, and

103 Conrad Totman, 'Forest products trade in pre-industrial Japan', in John Dargavel and Richard Tucker, eds., *Changing pacific forests: historical perspectives on the forest economy of the Pacific basin*, Durham, NC: Forest History Society, 1992, p. 21.

104 Osamu Saito, 'Forest history and the Great Divergence: China, Japan, and the West compared', *Journal of Global History*, 4, 3, 2009, p. 386.

105 Sugiyama, *Japan's industrialization*, p. 191.

106 *Ibid.*, p. 141.

107 Nisaburo Murakushi, 'The transfer of coal-mining technology from Japan to Manchuria and manpower problems: focusing on the development of the Fushun coal mines', United Nations University HSDP-JE series 47, United Nations University, Tokyo, 1981, p. 4.

allowed selected modern techniques to be implemented much faster than they otherwise might have been.<sup>108</sup> The mines of Hokkaido provide an interesting study of contrast: these mines were only really developed after the Meiji Restoration in 1868, in the absence of the accumulated endogenous coal-mining technology found in the southern mines.<sup>109</sup> Although steam engines had been introduced into Japan by this time (in fact, most Hokkaido coal was extracted for the purpose of fuelling foreign ships), the effective operation of these mines required the transfer of labour and skills from the Kyushu mines to the Hokkaido mines, as well as the importation of foreign labour and skills.<sup>110</sup> Even so, owing to an underdeveloped market and insufficient transportation infrastructure, this coal still cost 50% more than the average market price paid in Nagasaki, Kyushu.<sup>111</sup> Ultimately, it took the intervention of the Meiji government and a comprehensive programme of acquiring modern technology, as well as sending Japanese engineers abroad to learn the latest techniques, to make the mines viable. This process was not required in Kyushu, owing to the existence of an endogenous industry and the corresponding infrastructure upon which modern methods could simply build.<sup>112</sup>

While the use of coal may not have marked a major departure for Japanese energy use, once coal mining was established, it survived the pre-industrial period and made small but steady gains as a useful fuel in certain production processes. China also had coal mines and coal-mining abilities early on, but, as shown, these declined after the Song era owing to a series of catastrophes exacerbated by unsupportive government policies under later dynasties.<sup>113</sup> This was despite the fact that Osamu Saito characterizes China as a country with uncontrolled deforestation towards the end of its imperial period, and therefore surely a country with greater incentives to look for alternative fuel sources than Japan.<sup>114</sup>

In a certain sense, Japanese coal mining and coal use can be said to have inhabited some sort of middle ground between Chinese mining conditions and those present in Britain. Though the coal mines of Kyushu were not nearly as remote from urban centres as many of the Chinese coal deposits seem to have been after the move away from Kaifeng, they also faced transportation problems. Prior to the construction of railways in the latter half of the nineteenth century, coal mines, even those which had been partially modernized, depended largely on conventional water transport. This often led to an increase in the cost of coal owing to high transportation costs relative to fully modernized mines that could rely on overland railroad transportation.<sup>115</sup> In addition, Japanese geography is such that many rivers are short with very swift currents that were prone to frequent and violent flooding, thus occasionally making even river transport difficult.<sup>116</sup>

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108 Murakushi, 'Coal mining', p. 463.

109 Kasuga, 'Transfer and development', p. 1.

110 *Ibid.*, pp. 2–4.

111 *Ibid.*, pp. 4–5.

112 *Ibid.*, p. 5.

113 Pomeranz, *Great Divergence*, p. 65.

114 Saito, 'Forest history', p. 402.

115 Murakushi, 'Coal mining', p. 474.

116 Akira Hayami, 'Introduction: the emergence of "economic society"', in Hayami, Saitō, and Toby, *Economic history*, pp. 4–5.

Overland transport was similarly hindered by geography as well as by shogunal restrictions on the use of carts and wagons on the major thoroughfares connecting the major ports and cities to one another. The network of roads that accounted for the majority of traffic to and from Edo during the Tokugawa period was called the Gokkaido, and it was generally built for pedestrian rather than vehicular passage, intended especially to serve the free flow of official travellers and communications on well-maintained roads.<sup>117</sup> As a result, coal could not be easily transported over land, as any large quantities would have required the use of a wagon or cart. Coastal shipping may have made up for some of this, but the amount of coal mined and its use in salt production does not suggest that there was a fundamental shift in resource use that was leading towards something like an endogenous industrial or energy revolution.

In terms of production and use, the endogenous coal industry of Tokugawa Japan was fairly insignificant compared with output in Japan after modernization, or to the industry in Britain even before the Industrial Revolution.<sup>118</sup> The expansion of the Japanese coal-mining industry only began in earnest following the Meiji Restoration, in response to the introduction of Western steam-powered technology and to the state ideology of joining the industrialized nations of Europe on the world stage. Improvements achieved in coal mining over a century and a half did not bring Japan closer to inventing a steam engine, and coal mining generally does not appear to have been linked in any significant way to Malthusian pressures. It was the drive towards industrialization that fed the need for coal; it was not improvements in coal mining that led to industrialization. Rather, coal was an important resource for Japan during industrialization, and the existence of an endogenous coal-mining sector would have helped to support the growing need for coal once steam engines and railway networks began to be introduced.

## Conclusion

Japan provides an interesting case study, because, unlike China, it did eventually industrialize, and with great speed. Although this article has drawn attention to the exploitation of coal, colonies would also come to play a significant role in Japan's industrialization, albeit more as a consequence than as a cause, whereas neither coal nor colonies were relevant to the Chinese economy in the pre-modern era. This is not to suggest that China did not industrialize simply because coal mining ceased and colonies were not claimed, as many other factors, including European interference and state policy, certainly played a central role. What it does suggest, however, is that coal and colonies were ultimately important for both the first industrializer (Britain) and the first non-European country to catch up (Japan), if for different reasons. On the one hand, Britain increasingly mined and experimented with coal in response to timber scarcities and fuel demand, which arguably dovetailed with favourable state and institutional frameworks, to eventually produce a steam engine. In Japan, on the other hand, coal was essential for achieving the explicit state objective of joining the European powers on the world stage with enough speed to avoid potentially becoming a colony itself. Coal and the perceived

117 Constantine Vaporis, *Breaking barriers: travel and the state in early modern Japan*, Cambridge, MA: Harvard University Asia Center, 1994, pp. 36–45.

118 Murakushi, *Technology and labour in Japanese coal mining*, p. 5.

need for more resources would later provide at least some of the rationale for Japanese incursions into Manchuria. However, to borrow W. W. Rostow's terminology, Japan had certainly 'taken off' into modern economic growth by this time, such that this need for resources was not a cause but rather a consequence of industrialization. Prior to this, despite the Malthusian pressures of the Tokugawa period, the establishment and survival of Japanese coal mining in the pre-modern and early modern periods was not primarily motivated by resource pressures. Although coal would in the end be important for Japan, a comparative view suggests that the links between escalating resource pressures and expanded coal mining can be overstated.

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