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What room for accident in history?: explaining big changes by small events

By DAVID S. LANDES

There is a kind of historiography that I would call optative: history as it might have, must have, should have been.¹ One would not expect to find much of it in economic history, a branch that likes to pride itself on hard reasoning and exact proof; but we have it here as well. The classic instance is the debate over the social consequences of the industrial revolution (optimists versus pessimists). Both sides have been generous and ingenious in their mobilization of facts; yet both sides are essentially immune to them. One takes sides here because of conviction not by evidence, but rather by sympathy. And so in other classically inexhaustible debates: optative history is to be found whenever deduction takes precedence over induction, when the end (the result desired) determines as well as justifies the means.

I should like to devote my attention here to a special subspecies of the genus optative history—what we may call history as accident. As some might put it: there but for the grace of God . . . ; or for the wrath of God. . . . Or for the non- and unbelievers: a little nudge, and it could have, should have, gone the other way.

I

I would look at two examples. The first is the question of European world dominion: how did it come about? Here the analysis of the optative school is marked and motivated by regrets and lamentations. These have to do with what one author called ‘The rise of the west’—the rise of Europe to global supremacy in power and wealth.² After all, why the west? What strange, unhappy turn of fortune brought this wicked, greedy, aggressive civilization to the point of dominating the world, with loss of Eden (the Columbian legacy)—till revolution restore us and regain the blissful seat?³

Of course one way to understand this process is to see it in marxian terms, as expressed for example in *The Communist manifesto*: this triumph of one region over the rest of the world was the work and historical function of the European bourgeoisie. This view propounds in effect and paradoxically

¹ The article that follows is the 1993 Tawney Lecture, delivered at Hull at the Economic History Society's Conference, slightly revised to conform to the house style of this journal and to take account of criticisms from the readers. I have also inevitably introduced some afterthoughts, which do not alter the sense of the original text. I am grateful for comments and suggestions by François Crouzet, who does not always agree with me, but has saved me from error.

² McNeill, *Rise of the west*.

³ Cf. Sale, *Conquest of paradise*.

a linear, developmental logic of history, proceeding through stages—initially unhappy, exploitative stages—to an-ultimately happy end.⁴

And not only marxians; ironically, this was also the way the happy few, the lords of humankind, saw it: this was the white man's burden, manifest destiny, the triumph of virtue over the vices of ignorance and slothfulness, of superior races over 'lesser breeds'—in brief, the march of progress.⁵

Today, of course, this marching song does not play well. Triumphalism is out of style. Guilt and remorse become us. Even the marxist version of western dominion, critical though it be, is no longer acceptable. It gives too much credit to the villains of the piece. *The Communist manifesto*, after all, is a paean of praise to the bourgeoisie; and whereas that sort of thing may have been acceptable in the eurocentric nineteenth century, today it is not. Now other parts of the world are asserting themselves, either by their economic success or by way of compensating for economic failure, and they are reluctant to give the west credit for anything positive, however much unintended.

The task for some, then, has been to re-evaluate the nature of western dominion and cut it down to size. Why Europe? Why not Asia or, more specifically, China, India, or Islam? After all, it must have been a near thing. China, Jones tells us, 'came within a hair's breadth of industrialising in the fourteenth century'.⁶ That imagery (a hair's breadth) may be a little strong; but it does not seem unreasonable to affirm that China in the fifteenth century was richer than Europe, more advanced in certain areas of technology, unified politically and culturally, and capable of mobilizing human and material resources on a larger scale.⁷ Five hundred years earlier, the difference would have been much greater: Europe then was weak, 'peripheral' to the major centres of civilization, vulnerable to repeated aggression and incursion, and so poor as to have little to sell other than people; the resemblance to modern Africa will not have escaped the reader. On an *ex ante* basis, the probability in the tenth century of European world dominion would have been close to zero. Over the next 500 years, these

⁴ For Marx's viewpoint, see Avineri, ed., *Karl Marx*, esp. pp. 88-95, 132-9. For a more recent statement, Wallerstein, *Modern world-system*, p. 357: 'In the sixteenth century Europe was like a bucking bronco. The attempt of some groups to establish a world-economy based on a particular division of labor, to create national states in the core areas as politico-economic guarantors of this system, and to get the workers to pay not only the profits but the costs of maintaining the system was not easy. It was to Europe's credit that it was done, since without the thrust of the sixteenth century the modern world would not have been born and, for all its cruelties, it was better that it was born than that it had not been.'

⁵ On this good imperialist conscience and warm altruistic glow, see especially Kiernan, *Lords of human kind*, and *idem*, *European empires*, ch. 10.

⁶ Jones, *European miracle*, p. 160. Etienne Balazs, cited *ibid.*, p. 202, also sees the European achievement as an accident, monumentally fortunate: 'We have only to compare western society with China's bureaucratic society to appreciate fully the "miracle" that occurred in Europe during the sixteenth and seventeenth centuries. The concatenation of circumstances that brought capitalism to birth there and thus set in motion the industrialization of the entire world has all the appearance—when seen in this light—of being a freak of fortune, one of history's privileged occasions, in this case granted solely to that tiny promontory of Asia, Europe.'

Note the choice of words: 'miracle', 'concatenation of circumstances', 'freak of fortune', 'one of history's privileged occasions', 'granted solely'. Balazs sees this as an accident, but not one that China could have produced.

⁷ On the putative superiority of the Chinese, see McNeill, *Pursuit of power*, ch. 2.

odds would have had to be progressively adjusted, rising to almost one by the end of the fifteenth century.

India was less effective and weaker than China. It lay open to repeated foreign invasion and domination from central Asia, and was divided into ephemeral states (territorial domains) that never became nations. These states were typically plunder enterprises, organized to suck up wealth for the benefit of an often alien ruling elite. Such economic growth as happened took place in the face of, and in spite of, bad government. It could not go far, because property was precarious and was held at the pleasure of the ruler and his henchmen. Such state structures are typically brittle; hence the constant turnover of authority.

And then there was Islam, much of it newly unified under Ottoman Turkish rule (though never integrated); united also by religion and culture, strong in war (though dependent on a mercenary soldiery), and advanced in many areas of science and technology.

When one looked at the world, then, from about the year 1000, one could argue a different scenario. Europe took the lead, but it could have been, might have been, some other place, some other civilization. A tiny edge, an accidental advantage, a thin window of opportunity was converted into worldwide dominion and an enduring hegemony. This took the form, as we know, not only of a massive transfer of wealth in the form of booty and surplus, but of a transformation of the mode of production. But even this latter—what we have come to call the industrial revolution—is defined in this scenario as the consequence of the former. It was Europe's enrichment at the expense of the rest of the world that paid the bill for its economic achievements. Within this larger process, certain particular sources of enrichment are given special emphasis: the looting and extraction of bullion from the New World, or the drain of wealth from India, or the gains from the slave trade, or the gains from piracy and buccaneering that financed the slave trade—all of them heinous examples of European greed and oppression.⁸

A recent and extreme example of this view of history as accident comes from the geographer Blaut. Unlike Marx and Wallerstein, Blaut has no gratitude for European achievement. It was, he says, the product of chance. He sees, for example, no geographic or cultural reasons for European material success and political dominion. Temperate (he prefers 'midlatitude') climes, he assures us, are no more conducive to work, no healthier, than tropical. Modern technology and science could have been achieved anywhere; what he calls protocapitalism was making headway all around the globe until the end of the fifteenth century.

Then, because Europe happened to be closer to America, Europeans discovered the New World, and that changed everything. Europeans were not significantly stronger than the people they encountered, but the diseases they carried with them sapped and disabled resistance. The wealth they then extracted from the New World gave them a decisive commercial advantage that allowed them to make a hostile takeover of wealth and land in Asia and elsewhere. Blaut directs his sharpest shafts against what he calls

⁸ On the last, see Zahedieh, 'Trade, plunder, and economic development'.

the myth of the European miracle. This he unfortunately attributes to Jones, who in fact thinks that European success was anything but a miracle. Yet by adopting this title, he has exposed himself to Blaut's tiresomely repetitive animadversions, to the point of caricature.⁹

The effect of such an interpretation is, needless to say, to delegitimize European achievement—not only in conventional terms (it was bad, cruel, wicked), but as achievement. Wickedness, after all, is a universal characteristic: why prefer one villain to another? But here the accomplishment itself is reduced to the product of chance. Anyone could have done it. Europe just happened to be lucky.

It is not clear to me how one tests such a counterfactual proposition. One possibility is to examine the response of non-European societies to the European example, or to similar stimuli and opportunities. Were these other civilizations in fact ready to develop or, for that matter, desirous of developing along similar lines, to copy superior technologies and make them their own? My premise here is the economist's assumption that people will maximize and pursue rewarding activities if they can.

My first example would be that of China and its transoceanic voyages of the fifteenth century. Here we have a parallel to the European voyages of discovery, but earlier and on a much larger scale, reflecting the long experience of the Chinese in oceanic navigation. To cite just one contemporary observer, the Muslim historian Ibn Batuta, writing in 1347: 'Among the inhabitants of China there are those who own numerous ships, on which they send their agents to foreign places. For nowhere in the world are there to be found people richer than the Chinese.' And the ships, why they were 'like houses'. That was the way Zhou Chufei described them in the late twelfth century¹⁰:

When their sails are spread they are like great clouds in the sky. Their rudders are several tens of feet long. A single ship carries several hundred men and has in the stores a year's supply of grain. Pigs are fed and grain fermented on board. There is no account of dead or living, no going back to the mainland when once the people have set forth upon the caerulean sea.

It was big ocean-going vessels of this kind, five times the size of a Portuguese caravel, that made up the treasure fleets of the Three-Jewelled Eunuch, the Admiral Zheng He. Between 1405 and 1430, Zheng He led seven armadas, the largest consisting of 62 ships, on voyages of exploration and proclamation around the Indian Ocean and possibly the South Seas. The aim was to 'show the flag' to lesser peoples, to make them know and feel the superiority and beneficence of imperial China, to give gifts and collect tribute in return, and to bring back exotic flora and fauna, the strangest of which undoubtedly was an African giraffe.

None of that gave rise to continuing commercial relations, however, and in 1433 the Ming emperor suddenly banned Chinese merchants from going abroad. The great treasure ships of Zheng He were simply laid up, and the secrets of their construction were allowed to die with their makers. The

⁹ Blaut, *Colonizer's model*; Jones, *European miracle*.

¹⁰ These quotations are taken from Merson, *The genius that was China*, p. 73.

state archives were combed for records, which were then destroyed. China had made a decision to turn inwards, to abandon not only maritime but also coastal trade. It was safer that way. In 1411 the Grand Canal, the great inland waterway, was enlarged and reopened, and in 1415 sea transport of food and other supplies from south to north was abandoned. Without shipping, there would be no piracy. But without shipping, there would be no gains to trade.

In stark contrast stands the bulimic appetite of European sailors, their greed cloaked with missionary virtue, ready to venture on unknown seas in small boats and to put up with months of verminous crowding and famine to get their hands on the riches of the Indies, nothing deterred by failure or disappointment, each voyage a stepping stone to the next. Once they caught the whiff of wealth in their sails, no change in government policy, no want of official support, was going to stop them.

In general, the character of Chinese technological achievement needs substantial further consideration and scrutiny. In some areas, there is no question of Chinese precedence: gunpowder, compass, paper, movable type. In others it is now clear that the effort of some scholars to magnify Chinese achievements, by way of teaching triumphalist westerners a little modesty, led to exaggeration and error. The example I know best is the effort to credit China with the invention of the clock escapement and, indirectly, with inspiring the invention of the mechanical clock.¹¹ In still others, we are told of Chinese industrial practices that somehow aborted: the use of coke in smelting iron ore;¹² and the use of water-driven spinning machines in the manufacture of hemp.¹³ I confess that it is these last that trouble me most, primarily because such innovations are so superior to older techniques that they should have flourished, spread, and remained. Instead, we are told that they were eventually abandoned, perhaps because they made no sense to begin with in terms of factor costs, perhaps because of official discouragement (a strong homeostatic impulse), perhaps because, like the great but occasional Chinese hydraulic clocks, they represented discrete achievements unlinked to the needs and opportunities of industrial activity. *And perhaps (I would not exclude this) they never happened.* They were thoughts, velleities, designs—of a kind familiar from Islamic literature.¹⁴

My second example concerns the Ottomans and is a story of incomplete learning. In particular, the Turks understood the importance of cannon from their experience of combat against the Europeans. So they hired Christian metal founders and other artisans capable of making cannon—often Hungarian, because Hungary was their European march and the limit of their westward penetration—and with these produced, often at the scene

¹¹ Landes, *Revolution in time*, ch. 1. This story, hastily digested, has translated for some as the actual invention of the mechanical clock. Thus Jones, *European miracle*, p. 203, now corrected in his *Growth recurring*, p. 73.

¹² The primary source for this conjecture is the work of Hartwell, 'Markets, technology and the structure of enterprise'; *idem*, 'A cycle of economic change'.

¹³ McNeill, *Pursuit of power*, ch. 2; Elvin, 'China as a counterfactual', pp. 106-12.

¹⁴ Cf. the *Treatise on machines* of Razzaz al-Jazari (1206), from the designs of which a number of scholars have been only too ready to deduce real applications: Landes, *L'heure qu'il est*, p. 505, n. 11; p. 509, n. 24.

of siege (transport in the Balkans was next to impossible) some of the largest artillery pieces of the day. But they never learned to make and, more important, to improve cannon themselves.¹⁵ The same was true of their use of clocks and watches.¹⁶

My third example is similar and yet different. It is one of opportunity refused, the story of Japan and guns. Firearms were introduced in the sixteenth century and played an important role in the civil wars of that period. There are those who claim that not only did the Japanese learn to make and improve European-style muskets, but that around the beginning of the seventeenth century Japan was making more guns than any single European nation. And then this encapsulated society decided that guns were potentially subversive and banned them, except for those held in state arsenals for combats that never came. And that was the end of that industry: the Japanese could but chose not to.¹⁷

My fourth is in many ways far more important, because it is relevant to a long-standing grievance: the charge that European powers, by violence and extortion, aborted the industrial prospects of India and thereby stole the future. It concerns the mechanization of the Indian cotton manufacture. In the seventeenth and eighteenth centuries India was far and away the world's leading producer of cottons, which were a staple of trade in Asia and Indonesia and dominated the market in quality and quantity. Once the Europeans learned of these wondrously fine fabrics, they could scarcely get enough of them and trading companies fell over one another in the effort to secure pieces for import. Yet this huge increase in demand did not lead to any change in production technique—as did a comparable increase in Britain in the eighteenth century.

Why not in India? The answer is not yet known, and truth to tell, historians paid little or no attention to this kind of problem until very recently, so taken were they by the erroneous but comforting assumption that Indian possibilities of technological progress had somehow been stifled by Europeans. That was a politically correct view that fitted well with negative assumptions about European intentions and the intrinsically oppressive character of imperialism. That it contradicted the older and surely truer assumption that businessmen are in it for the money and couldn't care less where they made it, did not seem to trouble anyone. Another example, in other words, of optative history.

The problem nevertheless remains. On the basis of still preliminary research, handicapped by the scarcity of indigenous (as against European) documentation, one likely avenue of explanation would seem to be the

¹⁵ Cf. Guilmartin, *Gunpowder and galleys*; Inalcik, 'Diffusion of firearms'. On the incessant European search for improvements in firearms and the impatient diffusion of new techniques, as against the self-defeating complacency of other societies, see McNeill, *Pursuit of power*, pp. 95 ff.

¹⁶ A visit to the clock and watch room of the Topkapi museum in Istanbul is instructive in this regard. Of perhaps a dozen display cases, one is devoted to the work of indigenous horological craftsmen. The contrast between these machines and the imported European timepieces, both in appearance and technical quality, is enormous, even to the untrained eye.

¹⁷ Cf. Perrin, *Giving up the gun*.

elasticity of the Indian supply of labour.¹⁸ That may in turn have reflected one or more of a number of factors: demographic patterns, institutional limits on the bargaining power of labour, the availability of unemployed or underemployed labour in agriculture, and so on. There is a further problem: to what extent was the ability of these people to copy and emulate impaired by the impact of the west and their own impulses to cultural or religious resistance? The matter needs further investigation.

II

My second case study in optative history is taken from the fact of British precedence in industrialization and industrial revolution. This theme was long a staple, almost a cliché, of historical analysis and interpretation. A small library was written on the subject, to say nothing of blue books and term papers. Young scholars cut their teeth on the issue. And then came the Crafts article of 1977, which not only argued that there was no problem—that it could just as easily have been France that made the breakthrough to a new industrial mode—but that we should not be asking the question at all.¹⁹

This was like taking the bread out of the mouths of potential Ph.Ds. The Crafts thesis was, of course, radically different from the west-rest counterfactuals discussed above: no political agenda here. Instead, we had a play on mathematics and theory. We also had that rare phenomenon: the coming-out of a new, iconoclastic, and obviously exceptional talent. At one stroke all the years of explanatory effort were dismissed, and that on the basis of an intimidatingly unfamiliar methodology.²⁰

What exactly did Crafts say? How did he argue? In brief, he made three major points: first, that ‘the question “Why was England first” is misconceived and should be discarded rather than new solutions being sought’. In particular, secondly, he would distinguish a separate and more legitimate question: ‘Why did the industrial revolution occur in the eighteenth century?’ And thirdly he argued that the failure to make this distinction ‘may have been an important obstacle to an adequate interpretation of the economic history of France in the eighteenth century’.

But what exactly was wrong with the classic question, why England first? According to Crafts, England’s industrialization was a unique event, that is, it happened only once and there is nothing comparable. There is a strong tendency, moreover, for historians to see it as predetermined. They then reason backwards along two complementary lines: England’s special advantages; and the disadvantages and impediments of others, potential rivals, France in particular. All this creates and increases the risk of *post hoc, ergo propter hoc* fallacies.²¹

¹⁸ In marked contrast to developments in Britain, where growing scarcity of labour was a powerful incentive in the search for mechanical substitutes for human strength and skill.

¹⁹ Crafts, ‘Industrial revolution’.

²⁰ I confess that when I first read the article, I did not know whether to treat it as a spoof or as the too-clever-by-half lucubration of a very sharp graduate student or post-doc. I have since come to take it more seriously because others have been so much influenced by it.

²¹ It also leads to measuring the performance of continental economies ‘against a British yardstick’, which Milward and Saul (in *Economic development*, p. 30) see as a grievous methodological fault. Crouzet,

Crafts then proposes an alternative view. One should look at this event (the breakthrough to industrialization), he writes, as the working out of a set of comparative probabilities. Stating his point in mathematical language,

$$Y = a + B_1x_1 \dots B_nx_n + e,$$

where Y (the dependent variable) is the achievement of industrialization, the x s are diverse factors influencing the timing of this achievement, and e is an error term that represents either ignorance or chance or (I would say) both. In these terms, Crafts says, 'it may be, but need not be, that England was superior to France in terms of the probability of achieving the "decisive innovations" in the eighteenth century.'²²

Seen in this way, the result *in itself* does not reveal the *ex ante* probability of England's being first. Compare, writes Crafts, the problem of predicting the result of a football match: as the American dictum has it, any good team can beat any other on a given day or night. 'Given that the event is unique, the tools of statistical inference are inadequate to explain the timing of decisive innovations. Thus it can be fairly claimed that the standard question ("Why was England first?") is unanswerable.'²³ And if so, we should discard it.

III

The next step in the demonstration was to try to give content to 'e': how stochastic was the appearance and timing of invention? Without repeating the detail of Crafts's argument, I do not think I traduce it by summing it up as follows: after slaying a number of straw men, such as the 'great man' version of invention; and in the process misrepresenting a number of writers on the subject, in particular Usher, who in fact put forward a Gestalt psychological model;²⁴ and after conceding in effect that inventions are encouraged and focused by need and opportunity (demand) but are subject to uncertainty in realization (supply): we do not always get what we want when we want it; he slays another straw man, citing Musson to the effect that 'a theory of inevitability appears ludicrous'.²⁵ And then he concludes:

De la supériorité, p. 57, accepts this argument and does a *mea culpa*. I don't agree. All comparison—and we cannot do without comparison—means measuring against the characteristics or performance of others.

²² It would have been better had Crafts phrased this differently, for example: 'that England had a higher probability of achieving'. Words such as 'superior' and 'inferior' have a way of slipping from explicit to general, as they do in this article, with consequent ambiguities.

The 'decisive innovations' in the text are those of Davis, *Industrial revolution*, namely the spinning jenny and the water frame. Whether decisive in the sense of necessary and sufficient is another matter (there was more to the industrial revolution), but narrowing the story in this way helps to focus the probabilities.

²³ As cited in the version reprinted in Mokyr, *Economics of the industrial revolution*, p. 124. But as Crouzet has put it to me in conversation, this match was not the affair of one encounter; it was a continuing confrontation stretching over decades.

²⁴ See his *History of mechanical inventions*. To imply by citation that Usher somehow favoured the 'great man' theory is simply misleading; *c'était là son moindre défaut*.

²⁵ Musson, *Science, technology and economic growth*, p. 49. The victim here is Merton, who was imprudent enough to write that 'innovations became virtually inevitable as certain kinds of knowledge accumulated in the cultural heritage and as social developments directed the attention of investigators to particular problems': *Sociology of science*, p. 322. Merton would no doubt have come off better had he put this in terms of probability; thus: 'The probability of certain innovations became very high, say

first, that innovation is the result of 'stochastic search processes', which of course it is, but then so is all social and intellectual achievement, which is not to say that it is random; and second, that in such a stochastic world (our world), a country with lesser chances for economic development *ex ante* might get 'lucky' (his inverted commas) and win the race by chancing early upon a key innovation and going on from gain to gain. And that is certainly mathematically conceivable, if most improbable.²⁶ I know of no examples.²⁷

IV

The last part of the demonstration is an effort to compare France's chances of economic development in the eighteenth century with those of Britain: in Crafts's words, was the British economy 'self-evidently superior to the French'? His answer: 'a resounding "no"':

The fact that Britain was 'more advanced' in 1790 and had a much superior likelihood of further progress in the glamour industries of the period than France does not of itself necessarily imply that *ex ante* (in, say, 1740) Britain had the greater probability of achieving the first Industrial Revolution or that one should feel obliged to seek reasons for Britain's inevitable [*sic*] primacy going far back into her history.

This excursion into comparative economic history, in spite of Crafts's own contrary exhortations, may hold the key to this exercise in intellectual prohibition. The trigger may have been the publication of alleged data on French economic growth in the eighteenth century. Early in this work, at any rate, Crafts cites Milward and Saul: 'most recent research into the French economy in the eighteenth century has demonstrated that the increase in industrial output per head in the eighteenth century was probably faster than that in Britain.'²⁸

Now I should have thought that this finding that French industrial growth was more rapid than British in the eighteenth century would have incited Crafts to further investigation of the priority problem rather than leading him to dismiss it. To me, this is a conundrum—in those circumstances, why *should* Britain have been first?—and conundrums provide challenges and invitations.

0.8 or 0.9, as certain kinds of knowledge accumulated. . .'. Such are the hazards of verbal rhetoric. Still, 'virtually inevitable' is not 'inevitable'.

²⁶ Note that there is a certain careless tendency here to shift easily between invention and innovation. This is no trivial distinction. History is full of inventions that appear in one place and are exploited in others. Indeed, one of the generalizations made about France in the eighteenth and nineteenth centuries is that even when the French invented, it was other countries that profited; and conversely about Britain, that it was repeatedly 'pirating' the contributions of others.

²⁷ Here I have to express surprise, because Crafts's approach in this instance runs against the intellectual instinct of the discipline. It is true that the timing and place of invention are subject to chance. But the simultaneity of certain inventions (multiple invention) is evidence of the influence of demand and the connivance of supply, and economics has typically looked with disfavour on technology as an exogenous variable; instead, it has tried whenever possible to endogenize it, linking it particularly to demand and opportunity (rate of investment etc.). Cf. Schmookler, 'Invention of economic growth'; Mansfield, *Economics of technological change*.

²⁸ Milward and Saul, *Economic development*, p. 31.

To begin with, faster French growth is at the least unexpected and *prima facie* improbable. There is, for example, an abundance of contemporary witness (including the accounts of foreign visitors who came to see and learn) to the greater unity and efficiency of the British market, to the higher degree of entrepreneurial freedom, to the precocity of regional specialization; and although cliometricians tend to be scornful of such subjective observations, often derided as anecdote, I for one would be reluctant to take so many clearly intelligent people for fools. We also know much of the character of technological change in the two economies: in areas of enterprise common to both, the British were usually well ahead and opening the gap, as shown, for example, by the consequences of the Eden Treaty of 1786.

And why should British wages have been higher? I refer readers here to Adam Smith's brilliant analysis of the fact that wages were higher in colonial America than in contemporary London:

It is not the actual greatness of national wealth but its continual increase, which occasions a rise in the wages of labour. It is not, accordingly, in the richest countries, but in the most thriving, or in those that are growing rich the fastest, that the wages of labour are highest.²⁹

The same holds for the difference between England and France: the French were counting their daily wage in *sous* (one-twentieth of a *livre*); the British in shillings and pence; and it took about 25 *livres* to make £1. There is, to my knowledge, no systematic comparison of British and French wages (this is a task well worth undertaking), but the differences were striking: a quick survey would suggest a ratio of about two (or more) to one in favour of Britain.³⁰

In short, one has to make sense of numbers, and numbers have to make sense. At the unexpected tidings of French leadership, alarm bells should have been sounding in all directions.

V

There are at least two possible explanations of the anomaly in the economic performance of England and France: the figures are wrong; or our conventional wisdom is. The problem actually goes back a long way. Thus something of the kind had already been said by Nef, writing half a century ago:

According to the popular misconception . . . British industrial development was in sharp contrast to Continental throughout the eighteenth century, and not simply at the very end of it. But . . . the rate of industrial change from about 1732 to 1782 was no more rapid in Great Britain than in France, a far larger country with nearly three times as many people. What is striking . . . is less the contrasts than the resemblances between Great Britain and the Continent, both in the rate of economic development and in the directions that development was taking.³¹

²⁹ Smith, *Wealth of nations*, ch. 8.

³⁰ On French wages, see for example, Levasseur, *Histoire des classes ouvrières*, II, pp. 836-43.

³¹ Nef, 'Industrial revolution reconsidered', p. 5, cited in Crafts, 'Industrial revolution', p. 128.

Perhaps 1943 was a bad time to be writing; or perhaps no one really took notice because Nef continued to devote much of his time to explaining why Britain in fact preceded France (as in his 1957 book).³² In any event, the issue was revived in its modern form by an article to similar effect by Crouzet in 1966 which advanced, prudently and tentatively, the thesis of faster growth in France: 'We may well be justified in thinking that . . . the real increase in output and income per head may have been about the same in the two countries and possibly more rapid in France.'³³

This hypothesis has since become something of a datum or fact, in a way that seems particularly characteristic of economic history with its special passion for novelty. It was repeated in 1973 by Léon: in 1716, he wrote, French exports of manufactures amounted to 42 million *livres*; in 1787 they were 182 million *livres*—a fourfold increase in three-quarters of a century.³⁴ And more recently we have Crouzet's student Butel:

If one divides the rate of change in product by the rate of population increase, the image of a lagging France changes radically and one sees that over the course of the century output per head may well have grown faster in France.³⁵

Butel then goes on to cite even more emphatic figures: those of O'Brien and Keyder showing the rate of increase in industrial output from 1701-10 to 1781-90 as almost twice as fast in France as in Britain: 1.9 per cent to 1.1; and estimates of Mathias and O'Brien claiming that from 1715 to 1785, production of wealth per head at constant prices grew by 41 per cent in France, by only 5 per cent in Great Britain.³⁶

These numbers go beyond my credulity. They strike me as simply wrong, as the type of calculation that gives cliometrics a bad name. I can see, though, why this barrage of digits to the third decimal place might lead someone to decide that British precedence in industrialization made no sense, did not have to make sense, was the result of chance.³⁷

Not all facts are equal; and factoids even less. Let us go back to the sources. In his article of 1966, Crouzet, like Nef before him and Léon and O'Brien and Chassagne after, relied heavily on French trade data as an indicator of economic production. The data in question were the retrospective aggregate estimates of French officials assembled toward the end of the Old Régime—principally those of A.-M. Arnould, assistant director of the Bureau de la Balance du Commerce from 1785, and before him a certain Bruyard, head of the Bureau du Commerce from 1756.³⁸ We no longer have the raw

³² Nef, *Industry and government*.

³³ As reprinted in Crouzet, *De la supériorité de l'Angleterre*, p. 34, cited by Butel, *L'économie française*, p. 62.

³⁴ In a volume entitled *Aires et structures du commerce français* published by the Centre d'Histoire économique et sociale de la Région lyonnaise, and cited as a fact by Chassagne, 'Industrie et proto-industrie', p. 18.

³⁵ Butel, *L'économie française*, p. 63.

³⁶ *Ibid.*, pp. 63-4.

³⁷ Further to the question of the quality of the statistical constructs of British industrial and economic growth during the industrial revolution: Berg and Hudson, 'Rehabilitating'.

³⁸ For the grievous inaccuracies and lacunae of these returns and their pronounced upward bias of growth, see Landes, 'Economic development in western Europe', pp. 62-5. Note that Nef, 'Progress of technology', p. 22, citing 'for what they are worth' the data of Levasseur, *Histoire du commerce*, I, p. 512, n. 2, which Levasseur calls the 'moyenne annuelle probable', had already suggested that French

materials these estimates were based on, but this we do know: they are diversely composed and calculated; necessarily differ widely; are not standardized for comparison with British trade data; were very spotty to start with, and became more complete with the years, so that they have a strong upward bias. They seriously exaggerate the rate of growth.³⁹

The same is true of the reliance that Crouzet prudently, and other historians more credulously, placed on estimates of French agricultural output by Toutain—another building block of Anglo-French revisionism. The revisionists jumped too fast: two years after the Crouzet article, Le Roy Ladurie brought out a devastating rebuttal. Toutain, he said, was a colossus with feet of clay.⁴⁰ His data were ‘of an exemplary fragility’; in particular, Toutain (like Bruyard and Arnould) started with a very low base, so that his growth rate was badly biased upwards. Crouzet, on reflection, agrees that Le Roy Ladurie’s demonstration ‘is completely convincing. Nevertheless the British and American experts have continued [to use them], pointing out meanwhile that his estimates are upwardly biased.’⁴¹ Or consoling themselves meanwhile with the thought that the best, however bad, is good enough and better than nothing.⁴² So much for care and caution.

Let’s face it: economic historians, especially the self-styled new economic historians, have a visceral love for numbers, which are like honey to a bee. They also see iconoclastic data as a challenge, as an invitation to ingenuity. And if there is one thing one can say about the Crafts article, it was certainly ingenious.

VI

On the other hand, if scholars had taken Crafts seriously, they should have simply let his article go by. Dismissed is dismissed. Yet Rostow made answer, in the same journal.⁴³ Oh yes, argued Rostow, there is something to explain. We are not dealing here with an accident. Eighteenth-century Britain, he pointed out, repeatedly innovates; France, with rare exceptions, follows.⁴⁴ In Mokyr’s words, it is one thing to account for one throw of dice (thus Davis’s ‘decisive innovations’); quite another to account for repeated results.⁴⁵

What is more, those rapid and interrelated British technological advances

trade grew faster than British in the eighteenth century; but there too no one was paying much attention. Not even Nef, perhaps because he knew better.

³⁹ Bairoch, *Révolution industrielle*, pp. 331-2, estimates real growth of French exports at 60-80% from 1716/20 to 1784/8.

⁴⁰ Le Roy Ladurie, ‘Les comptes fantastiques’.

⁴¹ Crouzet, *De la supériorité*, p. 55.

⁴² Thus O’Brien and Keyder, *Economic growth*, p. 27. And then Cameron and Freedman, ‘French economic growth’, p. 8, endorse O’Brien and Keyder on similar make-do reasoning: their methods and sources are not above criticism, but then that is true of just about all quantitative assertions in history.

⁴³ Rostow, ‘No random walk’.

⁴⁴ Crouzet, *De la supériorité*, p. 51, cites Asselain, *Histoire économique*, pp. 88, 93, 97, as arguing along similar lines: French economic growth in the eighteenth century was extensive; British, intensive, showing an ‘aptitude for generating an increasing flow of innovation, built around a core of leading branches that open markets for and drive one another’.

⁴⁵ Mokyr, *Economics of the industrial revolution*, p. 7; Davis, *Industrial revolution*.

of the eighteenth century made sense. They bore witness to market logic, to the interplay between supply and demand, but especially demand. Given the composition and growth of the British industrial sector, it is not an accident that Britain produced the inventions and innovations it did; that France did not; and that even after the British had given the good example, the French, like other continental follower countries, had trouble keeping pace. Let me take up each of these points in turn, starting with the direction of innovation. The British focused on the invention of machines to replace labour in the manufacture of wool and cotton, *and wool first*—as one would expect from the relative position of these two branches of the textile industry.

The British were also the first to study the application of steam to the drainage of mines, which is what one might expect from a country that before any other made extensive use of coal in industrial processes. The first breakthrough was made by Thomas Savery in 1698: this autodidact, who set himself the task of creating a pump, imagined the simple, retrospectively obvious device of alternating high pressure steam and a vacuum produced by condensation. ‘The miner’s friend’, he called it. It was wasteful of fuel, but it worked. Later, in 1709, a blacksmith of Devon, Thomas Newcomen, built the first true reciprocating engine, and when he found that the device was covered by Savery’s patent, entered into partnership with him. These two, plus all kinds of rascally (enterprising) poachers, gave Britain a half century’s lead in steam power.

Contrast the career of Denis Papin: after a medical education in France, he came to England to work with Boyle and served as exemplar to Savery. In 1687 he designed a steam engine using cylinder and piston, but never got far with it; and in 1707 he built a steamship that was destroyed by German Luddites and was in any case too early for the technology. When he heard of the Savery pump, he claimed to have already done better and tried in vain to get the Royal Society to conduct comparative tests. That was the French way: invent something and get some academy or learned society to look at it. Papin would have done better to go to the mines. He died in obscurity in London with a steam pressure cooker to his credit.⁴⁶ Far be it from me to underestimate the usefulness of such a device, but it was not the making of an industrial revolution.⁴⁷

My second point concerns the difficulty of following suit. Can one say that Britain was richer in craft skills than the continental countries? That is a tricky question. If one wants to argue from example, it is not hard to find many extraordinarily gifted craftsmen on the continent, to say nothing of forms of artistic expression that were more demanding of manual deftness and dexterity than those practised in Britain. And yet there are skills and skills. The British pool of skills, especially in such areas as mill work and machine building, was apparently larger than that of the continental countries. I am reminded of the artists of Q’ing (Manchu) China and the

⁴⁶ Cf. his *A new digester or engine for softening bones*, shown to the Royal Society in 1679: Cipolla and Birdsall, *The technology of man*, p. 148.

⁴⁷ The contrast is also between theory and empiricism. Both Savery and Newcomen had close experience of mining problems, and their efforts were focused accordingly: *ibid.*, p. 148. The annals of science are filled with unproved devices and unrecognized ideas.

making of clocks: these were people possessed of extraordinary manual skills, and yet, as in Ottoman Turkey, their work as horologists was uninspired and even crude when judged by European standards. To quote Bedini, their clocks and watches were 'at best poor copies of poor copies of European timepieces'.⁴⁸ China continued to buy European timekeepers because they were better, finer, handsomer.

Note that I am not postulating a British monopoly of skills. Far from it. My point is just the size of the pool, its free, non-corporate character, and the direction (provenance) of its efforts and experience. These seem to have made a difference.

A third point now on the combination of direction and response. Consider the career of Henry Hindley of York (1701-71), clockmaker. An able maker of watches, clocks, and large tower clocks—thus, of small and large format—he was also an outstanding inventor and improver of precision tools (wheel-cutters and dividing engines), which could not only be used for cutting clock wheels but could be adapted to the development of heavy industrial gear-cutting machines. (It was no accident that the wheelwork of the early textile machines was called clockwork.) Hindley gave freely of his knowledge to John Smeaton, the great engineer, and in later life went into industrial engineering himself. The French had watch- and clockmakers, but they were not doing this kind of work.⁴⁹

Even when British and French clockmakers were engaged on a similar project, the character of the solution was different. Compare the two countries in their invention and production of the marine chronometer (Thomas Earnshaw versus Louis Berthoud). The British engaged in batch production using extensive division of labour; the French relied on a chosen *horloger de la Marine*, who made one chronometer after another. The British (Earnshaw and numerous others) made thousands; Louis Berthoud made 300 in a lifetime. The verdict: the British made some excellent chronometers because in so large a set there were bound to be outliers of excellence; whereas all the French chronometers were of high quality.

Another example: in the last years of the Old Régime, the French government, troubled by the domination of the Swiss watch manufacture and the substantial loss of specie to pay for legal and illegal imports, solicited from the leading watchmakers of Paris plans for the large-scale, mechanical manufacture of watches based on production of interchangeable parts. These plans offer an extraordinary insight into the mentality of these great and highly creative artists. Their primary concern was not the vision, but rather the danger. How was one to engage in such an operation, which would have the effect of substituting impersonal, embodied knowledge for personal

⁴⁸ Bedini, 'Chinese mechanical clocks', p. 220, cited in Landes, *Revolution in time*, p. 42.

⁴⁹ On Hindley and Smeaton, see Musson and Robinson, *Science and technology*, pp. 50-1. Compare the similar versatility of clockmaker Huntsman, inventor of crucible steel. Clock- and watchmakers needed a better steel for the manufacture of watch springs, and Huntsman's process remained a British monopoly and commercial asset into the early nineteenth century, when interruptions to trade gave continental countries a special incentive to learn the English technique. They got it, or something like it, from English expatriates (Jackson in France), industrial espionage (Fischer in Switzerland), and 'culinary' experiment (Poncelet at Liège; Krupp and others in Germany): Beck, *Geschichte des Eisens*, IV, pp. 128-36; Manchester, *Arms of Krupp*, pp. 33-9.

skills, without empowering workers to take the secret to other employers or set up in business themselves? In the event, nothing happened. The government filed the reports away; the Paris watch trade continued to devote itself to making the finest pieces (as with chronometers); and the Swiss, with cheaper labour, ran off with the spoils.

In general terms, then, the flow of innovation—time and space—is not a stochastic process. This is not to say that there are no elements of chance. It may be true, as someone said, that if James Watt had died of the pox as a boy, the steam engine with separate condenser might have been delayed a decade or more. But to say that the details are stochastic is not to say the process as a whole is one of chance, a random walk. Note that this combination of general tendency and random detail is characteristic of just about all social action and historical developments and of economic processes in particular. Ask anyone who has tried to make money in the stock market.

VII

What, then, are the determining factors that gave England its technological lead? I would look first at the demand side, not because of a causal model (demand drives; supply follows; or the reverse), but because one has to start somewhere. My own sense is that supply and demand are an interactive pair.

The key innovation falls within the Smithian paradigm: the adoption of rural putting-out. This goes back to the middle ages and represents a crucial departure from the town-based, corporate (guild) mode of production. The key is the division of labour and the recruitment into the production process of women and children. Say no more: the effect is to reduce costs and prices, increase demand, widen the market, promote further division of labour, lay the basis in specialization for small but cumulative improvements in technique. Smith does not talk about putting-out; he is too taken with pins. He missed a rare opportunity there; but then, one must not expect even the most brilliant and practical minded theorist to give up the unexpected for the banal (the purloined letter syndrome).

The effect of this fall in prices and increase in markets at home and abroad was to turn Britain into the workshop of the world. Crouzet knows this and points out that already at the beginning of the eighteenth century, 'the British economy was well in advance of the French'.⁵⁰ Observers at the time, on both sides of the Channel, also knew it.⁵¹

Crucial to this process of widening markets was the character of the commodities produced: woollens and then cottons and mixtures thereof. These were staple products, not luxuries, hence the elasticity of demand. It is from this point of view that one can best appreciate the character and limitations of French invention and innovation in textiles. The most important came in silk manufacture, primarily the Jacquard loom with its

⁵⁰ Butel, *L'économie française*, p. 61.

⁵¹ Milward and Saul, *Economic development*, much impressed by continental achievements, tend to deny or slight this, at some cost to their own story.

punch card controls, and reflected the same pressures on labour supply that marked British putting-out. The nature of the invention was revolutionary, with important implications for further invention in centuries to come (consider I.B.M. sorters in the twentieth century). But silk is a luxury fabric and was linked to an aristocratic-genteel style of life that would take a heavy blow from revolution and would never really recover; woven silks could never have the impact that woollens and cottons did.⁵² The French did not lack for talent or knowledge; but they were moving along different lines.⁵³

Now let us turn to the supply side. Once the British introduced their new machines and ways, it took some generations for the continental follower countries to imitate, establish technological autonomy, catch up, and in some instances overtake the leader. For all their own scientific knowledge and craft experience, they were not ready as Britain was for the new mode of production. Hence the systematic efforts, private and public, to hasten the process of diffusion. Does this mean that if there had been no Britain, no technological initiative, there would have been no industrial revolution? This is hardly likely; but it would have come more slowly, and it would have been different.

VIII

We may turn now to some methodological considerations. We have a paradox. The heart of the difficulty lies in the uniqueness of the phenomena studied. There is one first case (a sample of one) in both instances: one 'rise of the west'; one 'first industrial nation'; and the second instance is a subset of the first. That uniqueness would seem to preclude the usual comparativist strategy, and yet it poses the logical, the unavoidable, question, why this one and not that? And that implies comparison. It does *not* preclude comparison.

This uniqueness also compels us to go back through time and look for roots, origins, sources, causes. We have no other expedient, short of dismissing the question. This is what we call historical analysis, which for want of iron proof aims at plausibility and persuasiveness. To be sure, we are warned against the danger of reasoning *post hoc, ergo propter hoc*, which as everyone knows is a sin against logic. But caution is not prohibition. To avoid such a trap does not require us to stop seeking for explanations and causes, to stop reading back from outcomes. We just have to be careful to

⁵² Allen, 'Business mentality and technology transfer'. Crouzet points out that the silk industry in France was no small matter: it grew mightily and came to produce the most important French industrial export of the nineteenth century. Even so, it was not the making of an industrial revolution. The other textile fibres were more important, even in France.

⁵³ Even in silk manufacture, British and French innovation went different ways. The British invented and developed calendering machines (a power-using roller process with analogues in printing fabrics and paper and in shaping metal; the word 'calender' comes from cylinder) for the production of *moirés* and satins. The French went to great expense and effort to copy the technique, the effort drawing in government authorities from the municipal to the national level. In contrast, the Jacquard loom was a device to enable the weaver to make the most complicated designs using punched control cards. Machine and power on the one hand; art and cunning on the other. Was this coincidence, or international division of labour?

look for connections other than mere temporal sequence, for necessary and sufficient causes; also, where possible, to accept the test of the counterfactual.

There is also the trap of monism—the search for the one explanatory factor. This is a particular and persistent temptation for economists, who worship what they call parsimony and like to remind us that one good reason is enough. But it has to be good. Historians tend to be suspicious of simplicity; they see it less in events and developments than in the eye of the beholder. Large processes of historical change are not likely to hinge on single causes; many pieces have to come together. Hence, the presence or absence of particular features in other places should not lead us to expect or preclude parallel and simultaneous processes of development.⁵⁴

Here let me state a golden rule of historical analysis: *big processes call for big causes*. I take this as what economists call a prior. I am convinced that the very complexity of large systemic changes requires complex explanation: multiple causes of shifting relative importance, combinative dependency (by which I mean that some factors have different effects when conjoined or not with certain others), temporal dependency (by which I mean that it matters when changes occur, not only in sequence but relative to similar changes in other places). It will not do, for example, to cite European moves towards putting-out in the eighteenth century as the equivalent of the English move in that direction centuries earlier;⁵⁵ or to see the few, occasional steam engines on the continent in the mid eighteenth century, more often than not built for non-productive purposes, as the equivalent of the large British pool of mining engines; or to treat 50 years of French growth in the eighteenth century—50 years of recovery from a terrible trough at the end of the reign of Louis XIV—as the equivalent of a much longer period of English growth. On these and similar points, Crouzet has me right, though I disagree with his judgment: in matters of industrial technology, I do think the continental countries were substantially inferior to Britain, and growing more so over the course of the eighteenth century.⁵⁶

In general, I would argue for the necessity of aggregation as well as disaggregation—of giving the whole, changing picture and seeing change as a continuing process of innovation, response, adjustment, and the like. I would also argue for a kind of reality principle. It is *not* hard to devise mathematical models of intrinsic inevitability—of small differences that are reinforced over time to produce an ever-widening gulf, of lines of development locked into ‘path dependency’. But any resemblance between such lucubrations and the real world is purely coincidental and highly occasional—fortunately. The real world is made up of actors as well as of people acted upon. People and groups respond to change and challenge, evade constraints, and find other solutions. If Britain was first, if France was slower, if Germany was slower still but then caught up, if China did not make it, if China will now make it—all these things have their reasons.

⁵⁴ This is essentially the message of Milward and Saul, *Economic development*, pp. 31–9, as they discount one single-factor explanation of British priority after another. On the other hand, in their search for parallel circumstances on both sides of the Channel, they strike me as over-eager to believe.

⁵⁵ *Ibid.*, pp. 35–6.

⁵⁶ Crouzet, *De la supériorité*, p. 472, n. 118. He writes: ‘[Landes] overestimated in my opinion the inferiority of the continental countries’.

Once one has such a picture, I would be careful in fitting it to new and surprising data. I do not doubt the ingenuity of economic historians in this regard, but the pursuit of historical truth is an exercise not so much in ingenuity as in reason. Numbers should make sense. If they do not, it is highly desirable to scrutinize and verify them before rushing to a new paradigm. I think here of Kuhn and his stress on the reluctance of scientists to abandon old models.⁵⁷ Is it not ironic that natural scientists, who deal with much harder facts, are so cautious and conservative in assimilating them, whereas economic historians, with their factitious quantitative constructions and secondhand evidence, are so radical and credulous?

On this point I would cite some observations by the greatest economist of all those preceding Adam Smith. I refer to that novelist, essayist, travel writer, and great observer, Daniel Defoe, writing in his *Plan for the English commerce*:

Calculations in Cases where there is no Principle to calculate from, no given Number or Rule to begin at, should never obtain too much upon us; the judging by or from such Calculations leads Men, of otherwise great Penetration, oftentimes into fatal Mistakes, such as at least touch the Reputation of their Understandings and Judgment; and sometimes such as expose them to Contempt; such were the Guesses of that great Pretender to politick Arithmetick, Sir *William Petty*, whose Calculations of the Numbers of the Houses, and Families, and Inhabitants in *London*, and other populous Cities, were not erroneous only, but we may say have been since prov'd absurd, and even ridiculous.⁵⁸

Let me make a modest proposal. Economic history needs protection against bad numbers. The more artful our econometric techniques, the greater the recourse to quantification, the more protection we need. I would suggest that ways be found to weight numbers on a scale of reliability (robustness) and factor in these weights in all manipulations and combinations thereof. On a scale of 1, for example, estimates of French output in the eighteenth century might be indexed at 0.2 or 0.3, and when used in combination or contrast with other numbers, we might understand that the probability of an accurate result is close to nil.

Or we might index by estimated margins of error, and we would learn in this way that some numbers—like some questions—mislead and are inimical to the search for truth. How ironic that we are warned that words and terms may be misleading, that even questions may be misleading, but we are offered meretricious numbers as gospel. Even when the inventors of these numbers caution us, they cannot restrain the credulity of their readers and quoters. This is the law of diminishing robustness, which often combines with increasing conviction: the one needs the other.

IX

Solow likes to speak with a touch of condescension of twenty-twenty hindsight. When he does this, he speaks as an economist. Economists like

⁵⁷ Kuhn, *Structure*.

⁵⁸ [Defoe], *A plan of the English commerce*, pp. 128-9.

to think they can predict, that their challenge and task are to predict. Accurate hindsight is a lesser achievement.

But as the debates over these two *unique* historical processes show, hindsight is no simple matter. It is not to be taken for granted. Yet that is the historian's task: to learn how we (others) got where we (they) are. That this is not easy is a boon; so much the better for us historians. We shall not accomplish this task by indulging in any of the following 'sins': by insisting on absolute certainty (will-o'-the-wisp history); by believing counterfactuals, which are by definition untrue; by taking mathematical constructs/figments for reality; by turning complex processes into accidents where the combined probability is close to zero; by dismissing questions and thereby precluding or constraining inquiry. But Crafts, I am convinced, did not really mean this last. He just wanted to keep us on our toes.

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