Review essay

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Economic growth in history and in theory

Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress* (Oxford: Oxford University Press, 1990).

Douglas C. North, *Institutions, Institutional Change, and Economic Performance* (Cambridge: Cambridge University Press, 1990).

Mokyr and North both confront in these books the great question of economic history and of economic development: Why are we of the developed nations rich when most of our ancestors were poor, and remained poor for a very long time, and indeed when most of the current world is poor? In taking on this question Mokyr and North are seeking a breakthrough that would be the equivalent of the General Theory of Relativity in physics. They seek no less than the holy grail of economic history and economic development. As we shall see, while both Mokyr and North are no intellectual lightweights, and while they bring to their books considerable energies and talents, they fail in their quest. But with such an ambitious goal there is no dishonor in this, and we learn much from their attempts. To understand their quest, and their lack of success, we need some background.

The core of any society is a production process that transforms the primary inputs of land, labor, and capital into output and can be portrayed as in Figure 1.

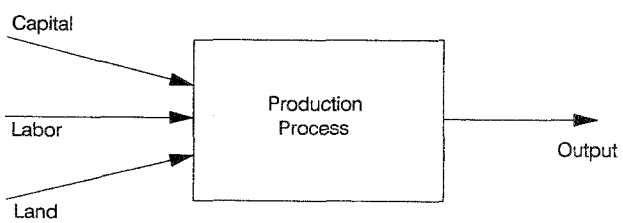

Fig. 1. The determinants of material output

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There are two ways in which output per person in any society can be increased. The first is by increasing the amount of land or capital relative to the number of workers (capital includes investments in education to increase the productivity of workers). For example, in England in the century after 1349 the population fell by almost a half as a result of visitations of the Black Death. This led to a substantial increase in output per worker, because of the increased amount of land and capital per person. Since the land area is generally fixed, the way in which incomes increase through expanding the inputs is generally by the mechanism of *capital accumulation*. This source of growth is, however, costly, and if pursued continually it loses its efficacy. It is costly because consumption must be sacrificed to accumulate capital, and it loses its power because as capital per person increases with a given production process further additions increase output per worker by decreasing amounts.

The second way output per person can be increased is by improvements in the production process so that the same inputs produce more output. This is referred to as *efficiency* gains.

In the advanced capitalist countries since the Industrial Revolution growth in output per person has been very great. It is estimated that the output per person in the United States now is about 20 times what the output per person in Britain was in 1700.[1] The proximate source of this great increase in material well-being has been overwhelmingly the increase in the efficiency of production processes. In Germany, for example, from 1950 to 1980 the rate of growth of income per worker-hour was 4.4 percent per year. Of this growth 3.1 percent can be attributed to efficiency gains, the rest mainly to capital accumulation.[2] But if we ask why Germans were accumulating so much capital in this period, the answer is mainly that as incomes grew, the stock of houses, shops, roads, and cars – the major elements of the modern capital stock – expanded proportionately. Thus as a deeper level efficiency explains not just the majority of economic growth, it explains almost all growth in output per person in the modern world, since income growth from efficiency gains also explains most of the capital accumulation.

So far so good. But why has efficiency been increasing so rapidly since 1770, when its growth was so slow for at least 10,000 years before then? This is the great question of economic history.

One answer to this question that has attracted some people is acci-

dent.[3] There are many cases in industrial history of chance and accident leading to discoveries that made fortunes and changed the world. Consider the recent rise of the British family firm Pilkington to an important position in the world glassmaking industry. The success of the firm can be directly attributed to the fact that Pilkington is an unusual name. In 1947 Pilkington was a reasonably successful glassmaker in St. Helens in Lancashire, which had been a tightly family controlled firm since its inception. In that year the firm recruited Alistair Pilkington, who was unrelated to the family but had come to their attention because he happened to have the unusual last name. He had just completed a degree in Mechanical Engineering and would otherwise have never considered entering glassmaking. The firm promoted him quickly, so that he was a director by 1955 and directed the firm's research, in part because of a decision to extend to him the nepotism reserved for "real" Pilkingtons. His lack of training in glass technology led him to devote most of the research budget to the revolutionary float glass process, where after many setbacks he made the important discovery. The eventual success of that innovation was the basis of Pilkington's modern international success.[4]

Could it be that the chance discovery of new technology in textiles circa 1770 taught people that technological progress was possible, so that they then attempted to remake the production process in every area of the economy? Could it have simply taken a long time for people to realize that discovery was possible and profitable? Mokyr shows that this notion of a quantum break between the pre-industrial and modern worlds is untenable. Technological progress and discovery took place at a significant but slow pace since at least the year 1000. Even that most famously backward of societies – medieval Europe – exhibited much technological inventiveness: in warfare, in cathedral building, and in the mundane tasks of agriculture. The rate of progress was slow only by the dizzying standards of the late twentieth century. Thus even in medieval Europe people were accustomed to looking for better ways to achieve material ends. Further, if we look at China we see a civilization where there was a period of solid technical progress up until 1400 followed by a long period of stagnation and inaction. It must be something other than chance that explains why the rate of technological progress was slow before 1770 and fast thereafter.

In an earlier work, *The Rise of the Western World*, North and Thomas give a spare and elegant way of thinking about this problem, which proceeds like a syllogism.[5] Thus:

Assumption 1: Technical progress is under the control of societies. There are many accidents, much good and bad luck, but any society that invests enough in trying to discover new techniques will eventually discover them.

Assumption 2: Private individuals will invest resources in trying to discover new techniques to the extent that the expected private material returns exceed the private costs.

Assumption 3: The private rewards from technical progress are dependent on social institutions. For the product of invention, knowledge, is a good that generally cannot be kept to the discoverer if it is employed in production. Thus only if society has a mechanism to give property rights in knowledge to the discoverer will there be much private reward.

From these assumption North and Thomas draw a conclusion and a corollary.

Conclusion: If technical progress does not occur it must be because the social institutions had not been established to reward investors in knowledge. Institutions are the key to innovation, and hence to economic growth.

The North and Thomas argument has an almost ineluctable logic. The assumptions seem relatively innocuous, but the conclusion they lead to is powerful. It is the "iron syllogism" of economic progress.

Corollary: From assumptions 1 and 2 we can infer that technical progress is all a kind of capital accumulation. Thus it is seen that at a deeper level capital accumulation is the basic source of economic growth. Marx had the correct title for his great work after all. Societies which grow fast are those that encourage the accumulation of capital in the form of investment in innovation.

This iron syllogism is powerful in part because it suggests an immediate empirical test of the role of institutions. We should be able to look at the period before and after 1770 in Britain and detect the institutional changes that created the Industrial Revolution. There should be a change that allowed inventors to collect more of the rewards of innovations by protecting their property rights in invention. We should also be able to identify institutional differences between Britain and other

European economies in 1770 that explain rapid British innovation thereafter.

North in *Institutions, Institutional Change, and Economic Performance* gives much play to the contrast between the institutional frameworks of premodern Spain (the failure) and England (the success). In England from the late middle ages government exactions were generally small and predictable, property rights were secure, and guild restrictions on manufacturing weakened early. Spain started from the same institutional background in the fifteenth century, but in the late sixteenth and early seventeenth centuries the institutions evolved into those of a weak government engaging in arbitrary wealth confiscations, a complex and exacting bureaucracy that attracted the best talents of the society, and state intervention in markets.

But North does not dwell on the disquieting fact that there was in fact little institutional change that affected the incentive to innovate in England between the Glorious Revolution of 1688, when the absolutist and Catholic James II was replaced by the Protestant and constitutionalist William and Mary, and the Industrial Revolution of the late eighteenth century. He also does not dwell on the fact that for many private actors in the English economy the Revolution of 1688 may have represented little change in their economic environment. Patent protection, for example, did not develop much in England between the early seventeenth century and the Industrial Revolution, and many of the most important innovations in textiles – the flying shuttle, the spinning jenny, and the mule – were never patented. Further, while Britain had a more effective patent law than other European economies, these economies made use of another mechanism of rewarding innovation which should have been just as effective. This was for the monarch to reward innovators with prizes or to support innovation through sponsoring manufacturing enterprises, as was done in France in the eighteenth century where large sums were paid out in this way (Mokyr, p. 249). In many ways such rewards are more desirable than patent protection. Patents give the inventor a monopoly for some period, which limits the use of the innovation. But lump sum prizes both reward the innovator and allow wide adoption of socially useful innovations.

North also does not dwell on the fact that the British imposition in India in the nineteenth century of just the very institutions he finds most desirable for economic growth – small and predictable government taxes, free trade, secure property rights, no price controls – created little economic growth in India between 1857 and 1949.[6]

North has not been so troubled by this, however, as by a conceptual difficulty with the original argument. He takes the iron syllogism as conclusive proof of the importance of institutions. What troubles him is that the third assumption of the syllogism takes the institutions of a society as given. But institutions can and do change. They are under human control. Why don't the rulers of societies always prefer institutions that foster rapid economic growth by adequately securing returns to innovators? One answer might be that people were ignorant of the importance of such institutions, or that they conflicted with goals of social harmony or the preservation of a ruling class. But societies have traditionally been in conflict, and technological progress has been an important force in creating the domination of some societies over others. Britain's success in the Napoleonic Wars was in part ensured by the growth in national income created by the Industrial Revolution. Also, poorer societies have frequently sought to emulate the institutions of richer ones. As early as the eleventh century, rulers in Eastern Europe were trying to improve their agricultural performance by importing settlers from the technically more advanced Germans. To attract them they offered freedom from the traditional feudal exactions.[7] The collapse of the Soviet Empire in the last few years is not so much the victory of one set of ideas over another, but the victory of a set of institutions that delivered a high degree of material comfort over a system that could not. And interestingly, the Soviet system failed because while it could produce high levels of accumulation of physical capital, it was very poor at generating technical progress.[8]

North has at various times considered a number of solutions to this troubling problem. In a paper written with Weingast, he and his co-author propose that one reason institutions that promote rapid economic growth will not be chosen can be that the ruler is *too* powerful.[9] An all powerful ruler faces a problem in that he or she cannot commit themselves to any contract with his or her subjects – they can always unilaterally repudiate the contract later. No one can be induced to invest in technical progress in such a society, they claim, since if they succeed they will have the gains confiscated. Only when a particular balance of power arises between ruler and ruled through such institutions as constitutional democracy can the power of the sovereign be diluted enough to make commitment, and hence investment, possible.

This argument works only if the world lasts for only a very short time. But when the ruler expects to be in power for many years, and when he or she cares about dynastic succession, this simple logic fails. For in

this case the ruler has no incentive to grab all the gains from private investments, since not doing so will induce further investment whose fruits can be confiscated at a later date. Reputation solves the commitment problem.

To get around this problem North and Weingast have to introduce the idea that the absolute ruler values future income very little compared to current income. The example they discuss is the cash strapped Stuart monarchs in England in the seventeenth century, forced to finance their wars by the selling of crown lands, by defaulting on loans, and by extracting forced loans. But why were these monarchs so cash strapped? It was because while they aspired to be absolute monarchs they were tightly constrained by a hostile Parliament in England, which controlled most of the taxing power. Had they been truly absolute they would have been less short-sighted. And even "absolute" rulers with limitations on their money-raising abilities, such as Henry VIII in England in the sixteenth century, showed enormous concern for perpetuating their dynasty.

Institutions, Institutional Change, and Economic Performance is the culmination of North's struggle to explain why societies would fail to construct growth-enhancing institutions. He affirms that "one gets *efficient* institutions by a polity that has built-in incentives to create and enforce efficient property rights" (p. 140). But breaking with his past he now concludes, very reasonably, that "it is hard – maybe impossible – to model such a polity with wealth-maximizing actors unconstrained by other considerations" (p. 140). Unfortunately this conclusion leads North to admit to the explanation of institutional choice a noisy rabble of all the pet concepts and theories of a variety of disciplines and subdisciplines. To understand institutional rigidity we now need to appreciate the importance of transaction costs, path-dependence, tastes, information costs, information asymmetries, enforcement costs, ethics, transformation costs, informal constraints, and procedural rationality. All this in a text of 140 pages. This produces a work of daunting complexity, which I must confess I was largely unable to penetrate.

At the beginning of the final chapter North writes, "to be good history, the story must give a consistent, logical account and be constrained by the available evidence and the available theory" (p. 131). Yet the previous 130 pages consistently violate this very reasonable requirement. North, having opened the book to all, is unable to control the resulting fractious mob. The resulting work has the same predictive

power as the statement, "What is, is," with none of its simple economy. Instead of the planned General Theory of Creativity, North delivers a creatively general theory. When compared to the severe elegance of the iron syllogism, developed in the introductory first eight pages of North and Thomas's *Rise of the Western World*, it is hard to believe that this work was produced by the same author.

Mokyr approaches the problem of technical change in a very different way from North. While North has the passion and fire of the monocausal fanatic, Mokyr is eminently reasonable and open-minded about all issues, so much so that his reasonableness becomes almost a disease. He considers a large variety of things that might have affected the rate of technological progress – including, but not limited to, nutrition, risk aversion, religious dogma, values, property rights, resistance by interest groups, political structure, war, and social structure – and concludes that yes, they all can play a role in technological change. But while it is entirely reasonable that many of these things did matter, that does not show that they did matter, or how much they mattered. And we have no idea whether a rigid religious dogma could be counteracted by a good patent system since there is no quantification of various effects. I know Mokyr would reject the idea that a theory of technological change is only truly a theory if it quantifies, but I cannot conceive of any other way of gaining knowledge about an empirical matter such as technology except through at least implicit quantification of effects.

To the extent that Mokyr offers a theory of technological change, it is in his exploration of "evolution" as a model for technological change. Here at least he seems to be drawing a line in the sand, to be making his territorial claim. By an evolutionary model Mokyr means one in which technological change is described in terms of blind mutations whose survival is controlled by equally blind selection processes. The gene in this case is the technological idea, and its carriers are the brains of persons in societies. In the process of use and transfer from person to person, these technological ideas get mutated by chance and by design, but only some of these mutations survive the selection process. Mokyr notes that there are two types of mutation. Microinventions are the incremental developments of some basic technological idea, while macroinventions are unexpected large changes in technique, which permit a host of new microinventions. Microinventions result from intentional searches for improvements to technique, and are thus influenced by economic incentives in the way that North and Thomas assume in their "iron syllogism." But macroinventions are governed by luck rather

than economic incentives. Their distribution across societies will not be dictated by institutions in the way North and Thomas would argue. Mokyr argues that macroinventions are not randomly distributed in time, however, the late middle-ages and the Industrial Revolution both experiencing clusters of macroinventions.[10] Thus some societies are more receptive to macroinventions than others, for reasons such as religious orientation and political structure. But there is no quantification of what constitutes fertile "social soil" for macroinventions to fall upon.

Nothing in the evolutionary theory seems objectionable, and the distinction between macro- and micro-inventions seems eminently reasonable. But theories can be unobjectionable for two reasons – because they are correct, or because they are so general as to be unfalsifiable. And I am afraid Mokyr's evolutionary theory falls into the second category. Nothing in Mokyr's scheme is quantified, and he is so reasonable and receptive to the conceivable objections and qualifications to the evolutionary parallel he wants to draw that he ends up making no concrete claim. The line in the sand proves to be a mirage when we get close to it.

An example of the problems created by Mokyr's reasonableness and openness is the discussion of the role of religious dogma in constraining technical progress. He initially appears to accept that the dogmas of religion will influence a society's rate of technological progress. This on its face seems implausible and old-fashioned, since history is replete with examples of dogma being artfully modified, or else simply ignored, when it conflicts with material gain.[11] Mokyr himself very reasonably notes that without any change in formal religious orientation societies have moved from being technologically progressive to stagnation, as in the Middle East and China. And he will as certainly accept that societies covered by the same or similar formal religious dogma have gone very different ways.[12] Mokyr also notes correctly that the religious dogma of a society cannot be taken as exogenous in many cases, so that even if religion and technological progressivity are connected, they may both be explained by some third factor. So the reasonable conclusion is that religious dogma can matter in some cases and will not matter in others. But how can we test this without an explicit theory of which cases it will matter in?

Mokyr, like North, accepts that growth is mainly technological progress. He, however, tries to avoid the logical vice of the iron syllogism.

In the introduction, he carefully refers to "technological creativity" rather than investment in technical progress, and he avers that there are indeed "free lunches" in technological progress. Mokyr wants to replace assumption 2 of the syllogism, which says that the *supply* of innovation is purely a function of the material rewards to innovation, with a more complex rendering. Instead, he argues that the supply will depend on *three* things, the size of the "cadre of ingenious and resourceful innovators who are both willing and able to challenge their physical environment for their own improvement," (p. 11), the economic rewards, and the social incentives. This leads us to richer social terrain. It should, however, be pointed out that it is a terrain trod over by many previous scholars. Crouzet and Landes, for example, have scoured the landscape of eighteenth-century England and France looking for the social differences that might explain why the Industrial Revolution occurred in England rather than in France.[13] Thus a problem for anyone writing now about social and cultural influences on innovation is what they can bring new to the subject. Also, the nature of the subject entails that enquirers have to walk a fine line between the fallacious and the platitudinous. Arguments in this area tend either to have obvious counterexamples or to have the platitudinous form "Societies are innovative when innovation is valued," without giving any independent test of what it means to "value innovation."

The issue of the supply of potential innovators and the social rewards for successful innovation are so intricately linked that they cannot be separated, and indeed Mokyr does not do so in his discussion. He believes the supply of potential innovators will be limited in many societies by the factors in the above-mentioned list. Some of the elements on the list seem a little quirky: he worries about protein deficiencies reducing intellectual capacities in pre-industrial societies. But many pre-industrial peoples were very well fed, because a rich disease environment ensured little pressure of population on resources. Most seem reasonable, but unproven. Mokyr is on more promising ground when he points out that while all societies have generally conferred prestige upon those who have great material wealth, they have also honored in varying degrees other accomplishments – prowess in war, in sport, in decorative arts, in piety, in oratory, in politics, and in learning. Suppose that it was very difficult in technologically primitive societies to offer material incentives to innovators which came near the social benefits their innovations would convey, because early innovations were easily copied and their use was hard to police. Then if innovators were motivated purely by material ambitions there might be

little innovation, because of the enormous risks involved. But if innovation conveyed also social prestige, then the failure of property rights might be bridged. Indeed, what is striking about the revolution in cotton textile technology in Lancashire in the eighteenth century is the limited attempts many early innovators made to reap material gains from their innovations, and the high praise heaped on the innovators by the community. The cotton textile industry in Manchester in the late eighteenth century was a community, with a sense of a shared stake in innovation, and a pride in innovation.

An extreme version of this argument might turn the North and Thomas syllogism on its head and add to it a fourth assumption.

Assumption 4: In the early stages of technical progress there is no practical way to reward innovators materially. With innovations that can be used on a domestic scale there is no way of policing property rights. Nor does the government have the incentive or the funds to reward innovators. Governments who foster innovation will bear the costs, but their enemies will fully participate in the gains, through direct appropriation of the knowledge. Better to let them pay, and then spy upon them.

Now we derive the following:

Conclusion: If technical progress occurs it must be because the society rewards innovators in other than material ways, through fame and admiration. Alternatively, technical progress can only occur if innovators themselves value it for other than the material rewards it conveys.

This new syllogism concludes that a society of rational, materially self-interested individuals, such as economists traditionally conceive, would be unable to foster the Industrial Revolution. It is in societies where material interests in production technology are replaced by intellectual, nationalistic, or moral interests that progress occurs in the early stages of Industrialization.

This recasting of North and Thomas maintains as a basic assumption that the amount of intellectual and creative energy per person is the same across various societies; it is just that in some societies these energies get diverted into profane uses whereas in others they are concentrated on the sacred, or on wasteful status seeking. This seems to be Mokyr's interpretation of the failure of classical Greece and Rome to

achieve technological breakthroughs in basic production technology that matched those in mathematics, pure science, in the technology of war, in civil engineering, and in administration. With all the intellectual energy available in the ancient world, the primitiveness of the basic production technology is surprising. The ancients never discovered the horse collar, the horseshoe, the stirrup, the windmill, the compass; all were discovered in medieval Europe. They made no substantial improvements in textile technology, the spinning wheel again being a medieval innovation. The argument that Mokyr would make is that these failures by an aggressive, acquisitive, and intellectually sophisticated people must be a result of a failure by society to value such types of knowledge.

Indeed, a standard criticism of society in the modern United States is that too much value and prestige has come to be attached to activities that do not create income, but merely seek to redistribute it. The desire to make a better laundry detergent has been replaced by admiration of attorneys, Wall Street money moguls, advertising executives, and politicians, most of whom exploit failings in the market and legal system to grab a larger share of the product of society.

There is a crucial difference, however, between asserting that values matter and showing empirically that values matter and what the appropriate values are. And in this Mokyr fails. The problem is that the qualities he brings to the subject – an impressive knowledge of the character of technological change throughout history and of the various things that might matter in determining technological change - are not those which can revolutionize this area. Many reasonable people with wide knowledge have considered this subject before and have come away empty handed. Mokyr is just not crazed enough for the task he undertakes. What is needed is a new strategy, a method to sift somehow through the competing claims, assign one or more priority, and then find a way of empirically testing that conclusion.

I do not have a general theory of technological creativity in mind, but I do have a number of suggestions for things we should be able to discover that would at least constrain the possible theories somewhat more than at present. These are:

(1) Are technologically stagnant societies characterized by a diversion of intellectual energy into other channels, or are they characterized simply by low levels of intellectual and other energies in all things?

That is, would medieval Europe have had modern rates of technological progress had they had fewer theological disputes, built fewer cathedrals, and fought fewer wars?

(2) Are technologically stagnant societies ones where the elite does not perform well, or is technological backwardness associated with the whole society performing its functions poorly? If all stagnant societies are characterized by poor performance all the way up the social and occupational ladder, it suggests that looking at values or issues that are peculiar to the elite will not explain backwardness.

(3) Are the constraints on performance in a stagnant society internalized by the individual, or externally imposed? That is, will the individual perform in the same way if placed in a different social setting, or is their performance independent of social influences?

(4) How rapidly can societies change their characteristics from technologically stagnant to technologically progressive ones?

In some sense what I am suggesting is that we need to return to the idea of forming a typology of what constitutes the "backwards" or "stagnant" society. The old typology of development economists in the 1950s and 1960s asserted that backward economies were traditional peasant societies, which lacked markets and trade, which were governed by custom and superstition, were pathologically risk averse, accumulated little capital, and which held limited opportunities for social and occupational mobility.[14] This typology did not prove very useful in analyzing technologically stagnant societies. First of all, it turns out that even in relatively stagnant societies such as England in 1300 there were markets for most goods, production arrangements in agriculture could be quite flexible, and there were many opportunities for advancement through pursuing economic gain. But it also turns out that within industrialized economies, or the industrialized areas of underdeveloped economies such as Bombay, Calcutta, Cairo, or Mexico City, there are marked differences in economic performance with little difference in the elements of social structure previously emphasized – the extent of markets, the dominance of custom, the possibilities for social mobility.

In line with at least some of these suggestions, I have carried out a number of studies looking at the source of income differences between countries. These find that there are remarkable differences in labor

intensity across countries on given technologies, differences so large that they explain much of the very large gap in wages across countries we see in industries such as textiles.[15] The relevance of such a finding to the issue of technological progress is that it does serve to constrain the set of explanations which look plausible. Thus, for example, the poor performance of the British economy in technological innovation since the late nineteenth century is often blamed on the culture of British managers, or on the family nature of many enterprises in Britain.[16] But if it transpires that at the same time as the management of cotton mills was failing to keep up technologically, the workers were lagging behind those in the United States and Japan in terms of their rate of performance in simple manual tasks, then the malaise afflicting the British economy has to be of a much wider scope than a peculiar disease of the managerial classes. Similarly, if we find that work intensity varied greatly across societies, we are more likely to believe that some societies suffer from a general lethargy, not just from a misdirection of their potential entrepreneurs' energies.

I think much more useful research could be done by examining the performance of those who move from economically underdeveloped to economically advanced societies, and vice versa. If the constraints on individual performance in poor societies are all externally imposed, then such individuals placed in advanced societies should perform indistinguishably from the natives of those societies, controlling for education. The problem with carrying out this test is that those that leave poor societies generally self-select and will not be representative of the general population. Also, in the new society the immigrant group may form a sub-culture largely insulated from the larger society. But there are cases where as a result of conflict whole groups get displaced so that self-selection does not get to play a role. Or the immigration policies of the advanced countries may be so arbitrary that there is little room for self-selection.

The performance of Chinese living outside China is particularly interesting in this regard. Ethnic Chinese have performed extremely well economically in such countries as Taiwan, Hong King, the United States, Canada, Australia, Singapore, and Malaysia. This would seem to support the argument that the failure of China to industrialize in the late nineteenth century was a prime case of obstruction from above by a xenophobic government. But when the Europeans gained control of treaty ports such as Hong Kong, Shanghai, and Tientsin, they gained access to the cheapest labor in the world in the late nineteenth and

early twentieth century. There would seem to be enormous profits awaiting capitalists who exploited this labor pool. But while there were substantial profits from cotton mills in Shanghai, the growth of the industry was slowed by the problem of extremely low labor efficiency. It is a very revealing fact that at the same time that Chinese immigrant labor in California was highly regarded by employers, Chinese immigrants to Shanghai cotton mills were regarded as, and can be shown to have been, relatively inefficient at their tasks. For it implies that the performance of any group, even at simple tasks, is highly dependent on the social setting they find themselves in. In other words, society, defined in a much broader sense than is described only by social institutions, sets the limits on achievement.

In short, I have no General Theory of Creativity to offer. But I do know that the General Theory of Relativity in physics only became possible when empirical work demonstrated conclusively that any theory of electromagnetic propagation would have to be constrained in certain very clear ways. I fear that a General Theory of Creativity is at present impossible because we have failed to establish similar constraints on the universe of possible theories. Attempts to construct one are premature. And further constraints will be established only by better establishing the ways in which creative and stagnant societies differ.

Notes

1. In 1985 dollars, income per capita in the United States in 1988 was $18,339. In the same units income per capita in England in 1700 is estimated at $945. Robert Summers and Alan Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–1988," *Quarterly Journal of Economics* (May 1991). N.F.R. Crafts, *British Economic Growth during the Industrial Revolution* (Oxford: Clarendon Press, 1985).
2. The numbers are from Richard Gregory and Robert Stuart, *Soviet Economic Structure and Performance* (3rd edn., New York, 1986), 332.
3. See Nick Crafts, "The Industrial Revolution in England and France: Some Thoughts on the Question, "Why Was England First?" *Economic History Review* (1977): 429–441.
4. T. C. Barker, *Pilkington Brothers and the Glass Industry* (London, 1960). Seminar, Stanford University, 1988.
5. See the introduction to Douglass C. North and Robert P. Thomas, *The Rise of the Western World.* Cambridge: Cambridge University Press, 1973.
6. Income per capita in India in 1860 was $248 (in 1975 dollars), while it had increased to only $332 by 1937. In the same period income per capita in Britain increased from $1181 to $2550, so India was becoming poorer relative to Britain under North's ideal property rights regime. Gregory Clark, "Textile History as World History: Britain, India, Japan and the USA, 1870–1980," unpublished ms.

7. See Jerome Blum, "The Rise of Serfdom in Eastern Europe," *American Historical Review* (1957): 807–836.
8. A colleague recently spoke with the President of a country that has been Communist since 1922 about which economic system should replace Communism. He suggested considering an innovative system, market socialism, which attempts to combine markets with social ownership of production capital. The President's view was that since Capitalism had been demonstrated to work well in Western Europe, he preferred not to risk an untried social system, but would simply imitate western institutions.
9. Douglass North and Barry Weingast, "Constitutions and Commitment," *Journal of Economic History* (1989): 803–832.
10. A problem with this argument, however, is that completely random sequences, such as a sequence of the numbers from 0 to 9, will often show clumping of observations. Mokyr does not formally test whether the clustering of macroinventions is marked enough that they could be declared to be truly non-random.
11. Islamic dogma, for example, forbids usury. But even Islamic states such as Saudi Arabia and Pakistan have no trouble providing a modern banking system, simply by calling it something else. Usury was forbidden by medieval Catholic doctrine, but that restriction was interpreted by canon law to apply only to a very small class on unsecured loans, and at the high finance end of the market even these restrictions were simply ignored.
12. Compare Catholic France with Catholic Haiti.
13. François Crouzet, *Britain Ascendant: Comparative Studies in Franco-British History* (Cambridge, 1990). David Landes, *The Unbound Prometheus* (Cambridge, 1969).
14. See, for example, Everett Hagen, *On the Theory of Social Change: How Economic Growth Begins* (Homewood, Illinois, 1962), 55–85.
15. See Gregory Clark, "Why Isn't the Whole World Developed? Lessons from the Cotton Mills," *Journal of Economic History* (March 1987): 141–173; "Textile History as World History," unpublished ms.; "Productivity Growth Without Technical Change in European Agriculture Before 1850," *Journal of Economic History* (June 1987): 419–434; "Productivity Growth without Technical Change in European Agriculture: Reply to Komlos," *Journal of Economic History* (December 1989).
16. See, for example, Martin Weiner, *English Culture and the Decline of the Industrial Spirit* (Cambridge, 1981).