

Prometheus 9 (1991), 413-417

The Lever of Riches: Technological Creativity and Economic Progress, by Joel Mokyr.

Oxford University Press, Oxford, 1990. pp. ix + 349

ISBN 0 19 506113 6

The Lever of Riches is an important book deserving close attention from students of the historical process that not so long ago was unashamedly called "progress."

Joel Mokyr is professor of economics and history at Northwestern University and author of *The Economics of the Industrial Revolution* (1985). The present work harvests the scholarship ripened in that endeavor by undertaking a systematic cross-cultural, longitudinal study of the causes and conditions of economic growth.

A central contention of this study is that contemporary microeconomics lacks the conceptual equipment to elucidate the increment to economic growth supplied by technological change. This is a startling claim: can a science founded in industrialising Scotland to explain the causes of the wealth of nations fail to explicate what everyone knows is the mainspring of economic growth?

Mokyr is aligned with a growing band of economists who believe that this is the situation, and who over the past three decades have attempted to supply a remedy. They call their heterodoxy "Schumpeterian economics." In the *Theory of Economic Development* (1912) and subsequent writings, Joseph Schumpeter emphasized that innovation is the fundamental impulse of capitalist production. Innovation is all-sided. Production, product, resource procurement, efficiency, and marketing are all drawn into the kinetic performance. The key to this dynamism was for Schumpeter the relentless, aggressive drive of entrepreneurs. His contemporary heirs replace the entrepreneur by the inventor as the chief wealth-producing agent, irrespective of time and place. While this assessment of the critical role of technology in wealth production will doubtless seem commonplace to non-economists, it is scandalous in microeconomics.

Readers are alerted to heterodoxy on the first page when Mokyr signals that his findings are at odds with "one of the most pervasive half-truths that

economists teach their students, . . . that there is no such thing as a free lunch.” We are apprised that it is the specific achievement of technology to deliver banquets for millions. It does so thanks to transactions between creative minds and nature that result in tapping natural powers and harnessing them to productive output. The wheel, the sail, the water mill, the wind mill (a wheel-sail), and the steam engine exemplify ways by which ingenuity coaxes nature into delivering disposable power, at a precise point, for application to production. These transactions occur outside the domain of market exchange, although they may and often do intersect with exchange. But it is not obvious to orthodox economics, whose doctrine is that technological innovation can be calculated as a response to market demand or else as a production cost. Mokyr, with other Schumpeterians, answers that technological input is supply-led in the double sense that technology creates products and services unimagined by consumers, and that technology creates the incomes that make a demand for technology possible.

Mokyr’s strategy for supplementing economics with a theory of technological innovation is this. He accepts the half-truth that growth can be understood within conventional calculi of commercial expansion, size and scale effects, and investment. This will capture “microinnovation,” that is, efficiency improvements and other changes that are made more or less spontaneously in the course of production. He is concerned to elucidate macroinnovation. Economic theory misses these events because it assumes economic actors to make rational choices subject to known constraints, whereas macroinnovation “involves an attack . . . on a constraint that everyone else takes as given” (9). Macroinnovators are economically speaking mavericks who would change the givens. Market reward doesn’t come easy for them, particularly when the distance from the bench to the shelf is great.

The investigative strategy is to focus micro- and macroinnovation simultaneously in selected time-slices, and to examine their cross-fertilisation as well as the intersections between macroinnovation and the market.

The study is divided into historical narrative and systematics. The narrative covers classical antiquity, the Middle Ages, and the development of technology in Western Europe from 1500 to 1914. The systematics is assisted by three comparative studies, of classical antiquity and medieval

Europe, of China and Europe, and of Britain and Europe. Each study develops a theme meant to elucidate why macroinnovations occur and the circumstances that influence their uptake into production. They illustrate of the book's centrepiece, an analytical chapter entitled "Understanding Technological Progress."

But our understanding of technological progress is still imperfect. The second part of the author's systematics attempts, as other Schumpeterians recently have, to forge links between the dynamics of technological change and the Darwinian analysis of evolutionary change. This is a very ambitious undertaking. I do not wonder that it is placed at the end of the book, since readers unversed in contemporary evolutionary theory are likely to find these pages hard going.

The narrative chapters prepare the ground by selectively reviewing innovations that were economically significant in the Western tradition. Incentives and disincentives to innovators, and conditions of uptake in applications, are shown wherever the data suffices. Phases of increase, decline, and stagnation are identified and their probable causes are traced. Attention is given to ambient values and their relation to social status, the multiple roles of political authority (including warfare), and communication. Mokyr also attempts to chart the pattern and frequency of inventions, to test hypotheses about spin-off effects and the relationship between continuous micro- and macroinnovation. One might have wished for some statistical analysis of these relationships, to augment the illustrations of inventions discussed

Let me attempt to summarize some of the results of this study.

- Opposition to technological innovation is culturally pandemic. Often it is income- and market-related. Labour combinations and tariffs, over many centuries, document attempts to protect inefficient productive methods. But there is also a syndrome of technology aversion. Islam and China after 1400 A.D. exhibit this syndrome after having passed through a long period of technology development. Both these brilliant cultures became progressively more risk-averse and xenophobic to the point of stigmatizing the imitation of foreign innovations. The description of the closure of these cultures greatly assists understanding the values and institutional prescriptions that arrest innovation; but what occasioned this turn-about? Mokyr believes that it expressed conservatism or risk-aversion at the

power centres of society, that is, anxiety about loss of social control. He speculates, as others have before, that the terrible destruction of the Mongol invasions may have traumatised these societies. This is important if true and one would hope that historians will continue to pursue it.

- Status values and the structure of preferences in a culture may assign low status to commerce or technology or both. This well-known diagnosis of Greek and Roman antiquity is confirmed by the author's investigations. He reminds us, however, that this preference structure was nuanced. The Greeks discovered the science of mechanics and developed metallurgy and machine construction to a high pitch. But in the Greco-Roman world machines of war and building construction were the only areas in which sustained applications were made.

- Governments do not figure in Mokyr's study as significant promoters of technological innovation. The positive role of the Mandarins prior to the onset of risk-aversion is emphasised, as is the strong affirmation of technology development in revolutionary and Bonapartist France. But these are exceptions; the author is more impressed by the tendency of governments to discourage innovation. The optimum recipe was the circumstance of early modern Europe, where a diversity of competing states and domestic institutions removed the option of risk-aversion taken in China and Islam. This diagnosis is confirmed by those cases where monarchs successfully imposed risk-aversion—Spain and Hapsburg went into economic decline. Since the author's history stops at 1914, we are left wondering whether the strong involvement of governments in R & D since 1945 marks a fundamental enhancement of the institutional capacity to promote technological innovation. The Soviet Union developed its technology entirely under government auspices, with mixed success. Perhaps Mokyr will explore this experience in a subsequent publication.

- The influence of ambient attitudes is discussed episodically throughout the study. The prevailing thought is that technological development is fostered best by an environment open to new ideas and new practices, which is not risk-averse and not intolerant, and which accords dignity to inventors and inventions. Religions are reckoned to be endogenous variables expressing a society's preference structure; Mokyr observes wryly that "every society . . . gets the religion it deserves" (171). The social rigidity of the Hindu religion strongly discouraged innovation, whereas the Judeo-Christian affirmation of man's dominion over nature

provided support for technological intervention. Lynn White's fine studies of the Benedictine order are cited to substantiate this claim. The Protestant ethic is not mentioned as a relevant consideration.

Coming now to innovation and invention themselves, Mokyr treats them as aggregates and seeks to discern their properties. He stipulates that growth through invention and innovation is "any change in the application of information to the production process in such a way as to increase efficiency, resulting either in the production of a given output with fewer resources (i.e., lower costs) or the production of better or new products" (6). An invention is an increment in the set of total knowledge of a society, which is in turn the union of sets of individual technical knowledge. Since an invention that isn't utilized is without economic effect, the on-going synchronization of invention and innovation are critical to sustaining economic growth. The absence of this synchronisation is the reason why few societies have been technologically creative.

The inventions meant above are "microinventions," consisting of variations upon existing technology. They can be the object of routine searches and they are in some measure responsive to demand. While they may bring substantial advantages, they are not pregnant with a future. Macroinventions, by contrast, contain in themselves the potential for clusters of inventions together with an abundance of free lunches. The pulley, the screw, the Bessemer process, the telephone, the turbine were inventions of this kind. Such inventions cannot be approached by a series of incremental steps. They require the formation of a new concept, a break with accustomed tinkering that is associated with creative imagination. That some macroinventions derived from accidental discoveries does not affect this valuation since only prepared minds recognise what has been found.

Microinventions are usually feasible on existing technology whereas macroinventions often are not. Numerous macroinventions appear first as crude and unreliable commodities whose sale capitalizes improvements of materials needed to construct the invention in the form originally conceived. In this example we see micro- and macro-inventions interacting. Mokyr lays great stress on multiple levels of mutual stimulation between the two forms of invention (297-98). Macroinventions seem to occur clustered in particular industries over short time durations, suggesting that emulation and the stimulus of new discoveries foster

discovery. The author also observes that the climacteric effect that occurs in particular firms or industries also seems to apply to the ebb and flow of macroinventions. This was first observed in Britain toward the end of the last century, when British industry failed to perform in the chemical and electrical industries. Mokyr invokes Cardell's Law to describe and explain a life cycle of macroinvention. The Law states that successful technological innovation leads to market dominance, which in turn leads to protection of dominance and risk aversion. When risk aversion is extended to inhibiting competing technological innovators, the firm or industry will decline relative to innovators who are outside the dominant firm's sphere of influence.

Space does not permit a discussion of Mokyr's extended analogy between organic evolution and the cultural evolution of technology. Despite the impressive ingenuity and diligence of this chapter, the structure is shaky. Evolutionary theory today is a state of flux between orthodox Darwinian uniformitarianism and heterodox punctuated equilibrium. Mokyr opts for punctuated equilibrium because it defends the possibility of macroevolution. Yet this is only a possibility whose underpinnings in genetics have not been convincingly established. Macrotechnological change, by contrast, is a fact of our direct experience. Is it fruitful to seek light on an evident fact from speculations of geneticists and paleobiologists?

A more pertinent and performable task, it seems to me, is to query the psychology assumed but never defended by microeconomics. Mokyr, as we have seen, identifies traits of the inventor and innovator that place him beyond the pale of the rational actor. This beginning could be extended to describe the cognitive and motivation psychology of what has been called "polytechnic rationality," basing this description on current research on human performance and human skills. This investigation would bring to light the marked sex differences in human performance, which would go some way toward elucidating the perception, expressed by some feminists, that technology expresses masculine dominance. It would also provide the study of technology a relevant evolutionary foundation in the human capacity for tool production and manipulation; and it would situate this capacity in the socio-ecology of our species. In this perspective one could articulate the implications of man's most important invention, the urban habitat.

Hiram Caton
Griffith University

Hiram Caton, D. Litt., is Professor of Politics & History, Division of Humanities, Griffith University. His is author of *The Politics of Progress: The Origin and Development of the Commercial Republic 1600-1835*.

Prof. Hiram Caton
Division of Humanities
Griffith University
Brisbane Q. 4111