

28 Policy conclusions

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This is a lengthy book, and a reprise should be kept very short. However, we feel it important to end with at least a few words regarding the implications of an evolutionary theory of technical advance for thinking about public policy. Not many, just a few.

From a traditional economic point of view science and technology policy will be guided by a set of relatively minimalistic questions such as: is there a case of market failure here or suboptimality in science or technological effort? Since Arrow's seminal contribution in this area some twenty-five years ago, there is general agreement that market failure is indeed one of the intrinsic characteristics in this area and that *underinvestment* in R & D will be the logical outcome of market allocation. The fact that technological advances can be readily copied will deter companies from investing in these, even though a significant advance would lead to enhanced efficiency or performance. Particularly, in cases where technological advances are not well protected by patents and easily copied, one can find plenty of examples of such R & D underinvestment. Before the advent of hybrid corn seeds, which cannot be reproduced by farmers, seed companies had little incentive to do R & D on new seeds, since the farmers, after buying a batch, simply could reproduce them themselves. The farmers themselves had little incentive to do such work since each was small and had limited opportunities to gain by having a better crop than a neighbour. Similarly, within an industry where scientists and engineers are mobile it is hard to keep secret for very long information about the broad operating characteristics of a particular generic design, or about the properties of certain materials. Such knowledge is not patentable and, if patentable, would be very hard to police.

On the other hand, and as the more recent contributions in the field of industrial economics (see e.g. Dasgupta and Stiglitz, 1980) have tended to emphasize imperfect market competition might also lead to *over* investment in R & D. There is virtually certain to be a clustering of effort verging on duplication, on alternatives widely regarded as promising, and often a neglect of long shots that from society's point of view ought to be explored as a hedge. The premium placed on achieving an invention first, so as to get a patent or at least a headstart, may lead to undue haste and waste and duplication of effort.

It is tempting to regard these kinds of 'market failures' as providing both justification and guidance for governmental actions to complement,

substitute for or guide private initiatives. At the least their recognition guards against the simplistic position that the R & D allocation is in any sense 'optimal'. However, such propositions about where and how market forces work poorly will not carry the policy discussion very far.

Indeed, in practice these arguments have led to the justification for active government support policies in the science and technology field, with government support for R & D investment as the (only) central issue at stake. Big national and international R & D projects financed and planned directly by the state have thus become some of the most dramatic illustrations of 'government failure'. Elsewhere, one of us (Nelson, 1982, 1984 and 1987) has discussed in detail the conditions under which this is more or less likely to occur. The complexity and subtlety of the problems involved suggest that general principles and propositions about the appropriate roles and relative merits of governmental and private activity in the field of R & D policy will neither describe the experience accurately nor provide much normative guidance.

From these couple of comments it will be clear that in our view and in line with the other chapters in this book orthodox economic theory will be of little help in recommending reasonable policies in the field of science and technology. As Nelson and Winter put it: 'Orthodox theory cannot adequately provide that analysis and understanding because it is an ahistorical world in which genuine novelties do not arise.' (Nelson and Winter, 1982, p. 413.)

The 'anatomy of market failure' discussion in neo-classical economics is indeed focused on equilibrium conditions of stylised market systems. What the chapters in this book suggest, in line with evolutionary thinking, is that such a discussion should properly focus on problems of dealing with and adjusting to change. It involves in the first instance abandonment of the traditional normative goal of trying to define an 'optimum' and the institutional structure that will achieve it, and an acceptance of the more modest objectives of identifying problems and possible improvements. In part it also represents a more general acknowledgement that notions like 'market failure' cannot carry policy analysis very far, because market failure is ubiquitous.

Common to the theoretical approaches sketched out in the various chapters in this book is an understanding of the process of technical change, as being truly evolutionary in nature. Such evolutionary processes particularly with regard to technical change, will be inherently wasteful, at least with the vision of hindsight. There is, for example, as already mentioned in our previous discussion on 'market failure', bound to be duplication or near duplication of effort. Economies of scale and scope that might be achieved through coordination will be missed. Certain kinds of scientific or technological research that would have high social value simply may not be done because they would not yield proprietary advantage, or because no one is minding the overall portfolio. To the extent that technology is proprietary, many enterprises might be operating ineffi-

ciently, even failing at a considerable social cost, for want of access to best technology.

Within such an evolutionary approach, policies with regard to technological change encompass not just R & D, but the whole spectrum of scientific and technological activities from invention to diffusion, from basic research to technological mastery. As a parenthesis, and reiterating the point made in many of the chapters in this book, such a view of technological change rejects also the orthodox economics definition of technological capabilities in terms of 'knowledge' or 'information' with the connotation that industrial technology is like a recipe; understood by particular individuals and readily articulatable and communicable from one individual to another with the requisite background training. From our perspective, what is written down—the recipe, the textbook discussion, the patent—provides a start, but only in the sense that a recipe provides a start. Knowing how to produce a product, is as much experienced tacit skill as articulatable knowledge. And contrary to the implicit general theory the tacit skills of one 'skilled in the art' are not interchangeable: who works with the recipe makes a difference.

At a more general level, such a view points to the importance of the technical as well as social integration of technological change: within firms as much as within society at large. The implicit idea in the orthodox economics view of technology that what one firm can do, others firms can do too, if they had access to the relevant 'information', is not only rejected but replaced by the fundamental question about what determines the kinds of technological capabilities firms get under control and how these capabilities do evolve over time. Similar questions as illustrated in the chapters in Sections V and VI can be raised at the country level.

In other words, the recognition that the creation of technological capabilities involves an evolutionary, endogenous process of change, negotiated and 'mediated' with society at large, implies that policies in the area of science and technology will not, nor should be limited to questions about the economic 'integration' of technological change, but will include all aspects of the broader societal 'integration' of such change. Indeed it will be the broad societal context: including economic, but also social and ethical factors which will set the conditions within which technological change will be adapted, even selected.

From the dynamic, evolutionary perspective presented in this book, the long-term implications of technical change, the 'externalities' of orthodox economics, will not be susceptible to definitive once and for all categorisation and are intimately related to particular historical and institutional contexts. To a large extent, the problems involved are aspects of economic change. The processes of change are continually tossing up new 'externalities' that must be dealt with in some manner or other. In a regime in which technical advance is occurring and organizational structure is evolving in response to changing patterns of demand and supply, new nonmarket interactions that are not contained adequately by prevailing laws and

policies are almost certain to appear, and old ones may disappear. Long-lasting chemical insecticides were not a problem eighty years ago. Horse manure polluted the cities but automotive emissions did not. The canonical 'externality' problem of evolutionary theory is the generation by new technologies of benefits and costs that old institutional structures ignore.

From such a perspective the concept of a 'social optimum' disappears. Occupying a central place in the policy analysis are now the notions that society ought to be engaging in experimentation and that the information and feedback from that experimentation will be of central concern in guiding the evolution of the economic system.

The array of present policy debates about some of the long-term, *international* 'externalities' of change, and technological change in particular, in terms of impact on the physical global environment (air, land and water pollution), or even in terms of impact on society's future genetic capital (genetic manipulation, pre-embryo research), or on privacy, cry out for such a new technology 'assessment' and institutional experimentation in the field of science and technology. Confronted with rapid scientific and technological change, governments are today faced with a major challenge. How to assume the State's function as social 'regulator' of technical change in a period of deregulation 'destruction *tout-court*', aimed itself at stimulating further innovation. As Jean-Jacques Salomon puts it: 'Si les moeurs précèdent la loi, comme disait Montesquieu, le changement technique précède les moeurs et la loi' (Salomon, 1987). In a period in urgent need of a new regulatory framework, it will be tempting to equate the need for 'less State', with the notion of 'technological laissez-faire'.

But, in our view, that would be a serious mistake. The argument that it is important to keep on experimenting, and that private enterprise is a powerful mechanism for doing that, by no means implies that what private parties find profitable to do necessarily should be accepted by society. There is an essential governmental role in monitoring as well as encouraging innovation. While fears of an Andromeda strain perhaps are exaggerated, experience with nuclear power should warn that new technology is not always benign. It is not yet clear what is happening to the world's ozone, but it is clear that it is important to be attending to that matter and to be prepared to marshal the forces that only governments can deal with the problem.

The ozone problem signals that the issues raised by new technology not only require government regulation, but challenge the current system of national governments and only limited means of world governance. The ozone issue, may, or may not, come to equal or dwarf the problems of arms control. At a less dramatic but more insidious level, there are the worldwide issues created by the new information systems. It is not clear that humankind currently has the governing strategies to deal with these adequately.

In this volume several authors, but especially Carlota Perez and Christopher Freeman, have proposed that we are entering a new era with a

drastically different operative economic-technological paradigm. Not all of the authors of this book would put the matter as sharply. But all would agree that there are important new things going on and to be monitoring. Let the exploration go on. Let it be urged and supported. But new government structures and public laws will be needed to support the valuable of the new, and to constrain the pernicious.

References

- Dasgupta, P. and Stiglitz, J. (1980), 'Industrial structure and the nature of innovative activity', *Economic Journal*, vol. 90, pp. 266-93.
- Nelson, R.R. (ed.), (1982), *Government and Technical Progress: A Cross Industry Analysis*, New York, Pergamon Press.
- Nelson, R.R. (1984), *High Technology Policies: A Five Nation Comparison*, Washington, DC. American Enterprise Institute.
- Nelson, R.R. (1987), *Understanding Technical Change as an Evolutionary Process* (de Vries Lectures in Economics, Vol. 8), Amsterdam, North Holland.
- Nelson, R.R. and Winter, S.G. (1982), *An Evolutionary Theory of Economic Change*, Boston, Mass., The Belknap Press of Harvard University Press.
- Salomon, J.-J. (1987), 'Implications sociales des nouvelles technologies', OECD, SME, Paris, mimeo.

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