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# Can the Nelson-Arrow Paradigm Still Be the Beacon of Innovation Policy?

Manuel Trajtenberg

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The Nelson-Arrow (N-A) paradigm, as espoused in the volume commemorated in this conference, is widely regarded as one of the most consequential developments in economics, shaping the views on innovation and on science and technology (S&T) policies prevalent ever since, and generating an enormous volume of subsequent research. It has justly earned its place in the dual “hall of fame” of economics and public policy, and constitutes a worthy sequel to the much celebrated *Science, the Endless Frontier* by Vannevar Bush, the outstanding science guru of President Franklin Roosevelt.

The N-A paradigm basically postulates that the production of new knowledge entails significant externalities that are difficult to appropriate, thus opening up a wide gap between social and private rates of return to inventive activities. Such a gap, coupled with acute risk and the specter of moral hazard in financing R&D, results in systemic underinvestment in R&D, lower than socially desirable rates of innovation, and hence slower economic growth. Two types of policy instruments are thus needed to counteract those failures: the first to *increase appropriability*, mostly via intellectual property (IP) protection; the second to address *underinvestment in R&D* directly via various forms of government subsidies, the more so the more basic the nature of research is. This is postulated implicitly in the context of a closed economy; that is, one lacking significant international flows or leakages that could alter this basic line of reasoning. Fifty years later the logic of N-A is still intact, but there are a number of question marks that have arisen in the past few decades that deserve careful consideration:

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1. How much underinvestment in R&D is there, really, and hence what is the “optimal” amount of R&D at the macro level?
2. What sort of R&D should we promote; that is, is there room to deviate from neutrality and do some form of “targeting”?
3. How does diminished appropriability fare vis à vis widespread sharing activities associated with the Internet, to be labeled “wiki-motives”?
4. How do the policy prescriptions of the N-A paradigm, predicated basically for a closed economy, hold up in the face of globalization of S&T?
5. Is the N-A paradigm relevant also for developing economies?

## 1 How Much Underinvestment in R&D?

As already mentioned, the N-A paradigm generated a very large amount of subsequent research, both theoretical and empirical, but little of it was *directly* concerned with policy, certainly with macro policy. Thus, whereas the broad strokes of policy are quite clear, the devil is in the details, and in that regard available research offers rather poor guidance. Take the presumed underinvestment in R&D—what do we know about the magnitude of the gap? Is the 2000 Lisbon goal of  $R\&D/GDP = 3$  percent a reasonable one? Does the fact that Israel displays the highest R&D/GDP ratio in the world (4.8 percent) necessarily mean that it is doing the right thing in this respect? We have to admit that we have a very limited conceptual and empirical base to address these and related questions, which are further complicated by the following considerations:

- It is very hard to tell apart (and we often tend to confound) average and marginal effects in this context (from spillovers to appropriability to subsidies), and what we typically need for policy are the marginal effects.
- What we truly care about is not formal R&D per se, but rather the overall amount of innovation and its implementation. “Tweakers” (to paraphrase Joel Mokyr) may be as important as R&D personnel, but the former barely find their way into economic statistics, and are hard to target via economic policy.
- As argued by Paul Romer, spending more on formal R&D may end up just inflating wages of R&D personnel, and not producing more innovation.
- Clearly, it cannot be that high R&D/GDP ratios are necessarily a good policy prescription for every economy: comparative advantage holds in this context as much as in any other, and besides, it is not a bad idea to free ride on international spillovers.

The unpleasant truth is that we may have to admit ignorance in this regard, at least until further research brings in some useful insights, and thus leave aside aggregate, macro targets (such as the Lisbon one). Instead,

we should focus on micro aspects that may have economy-wide effects, such as improving the institutions that facilitate innovation, with the R&D/GDP ratio being just one end result of that.

## 2 What Sort of R&D? Neutrality versus Targeting

R&D is widely heterogeneous, as are innovations themselves, ranging from basic scientific research in esoteric fields to mundane development. We presume that the gap between social and private returns is wider the more basic research is, and conversely for applied research. But that may not be quite so: to begin with, social and private returns may be highly correlated: for example within some lines of research in biotech the returns are surely “high social,” “high private”, whereas in some obscure research area in economics these might well be “low,” “low”. It is not clear which of them deserves more support, if at all: after all, if private returns are sufficiently high, they may be enough to generate “enough” R&D. On the other hand, if public returns are low there is no reason to support research to begin with. What we should be looking for are fields where there is a *negative correlation* between the two: high social but low private returns. If we could identify them, we would have a powerful tool for targeting. The message is clear: we should devote more research efforts not only to the overall gap between social and private returns to innovation, but to assessing the nature of the gap for specific research fields.

## 3 IP and Appropriability versus “Wiki Motives”

Many in this conference as well as others have voiced increasing concerns in recent years that the means for IP protection may be actually stifling innovation rather than encouraging it (e.g., too many patents, too much fragmentation of IP for every bit of knowledge). If so, one of the key policy prescriptions stemming from the N-A paradigm is seriously questioned. On the other hand, *sharing* knowledge and information in cyberspace have become a widespread driving force, as manifested in social networks, open source ventures, the “wiki” movement, and so forth, involving collaborative activities of vast numbers of people. Sharing as a powerful motive is truly novel, and was nearly inexistent in this context as recently as a generation ago. We are only beginning to understand the incentives that may underlie such behaviors, and there is a long way to go in that regard.

To the extent that innovation involves “recombinant ideas” (as suggested by Martin Weitzman), cyber-sharing may become a powerful countervailing factor to the appropriability deficit. Furthermore, the Internet, search engines, and related technologies are turning knowledge more and more into a true public good, thus enormously increasing the social (worldwide) value of both the stock of knowledge and increments to it. An apparent

paradox arises in this respect: on the one hand cyber-sharing should increase the gap between social and private returns as traditionally defined. But if private returns include (as they seem to do) nonpecuniary elements that are positively related to the extent of sharing, then in fact the gap may have narrowed as a consequence. If so, perhaps S&T policy should be aimed more at making sure that cyberspace remains wide open, encouraging sharing, and so forth, and not at fostering more IP protection. Be as it may, there clearly are sharp trade-offs between the two, which need to be further investigated in order to inform policy.

#### 4 Globalization of Innovation versus National S&T Policies

There is a basic incongruence between S&T policies being formulated for the most part at the *national* level, and the fact that the objects of these policies (e.g., science, R&D, innovation) take place in a global dimension, and are governed by forces that escape to a large extent national control. Suppose, for example, that a particular country wants to attract multinational corporations, and in particular that it offers incentives to set up R&D labs in its territory. Who will actually benefit from the R&D done there? Will it be mostly the local economy? Who will ultimately own the IP generated in such a lab? The answers to these and similar questions are far from clear, and yet absent hard evidence or reasonable presumptions in that respect we cannot assess such policies. One can easily replicate this dilemma in virtually all other areas of S&T policy: the fact is that both the inputs and the outputs of R&D and innovation do not respect borders, are increasingly mobile and fluid, and devoid of clear institutional or geographic anchors. To insist, this creates a fundamental incongruence between country-level policies and the objects of such policy.

One telling aspect of this incongruence is the fact that virtually all players, big and small, developed or emerging, are deeply concerned about the implications of globalization in science, technology, and R&D. Thus the United States is concerned about the fact that significant portions of innovative activities have moved to other countries, driven by the wide availability of talent elsewhere. On the other hand, emerging economies are disturbed by the fact that innovations generated in their midst by guest multinationals end up benefiting somebody else. “Host” and “guest” (for R&D) countries can easily be discussing the same sort of concerns from diametrically opposed standpoints. Likewise, brain gain for one is obviously brain drain for others, but then in a further twist returning diaspora scientists and engineers may undo the flow and generate opposite anxieties.

The proliferation of government support to R&D in ever more countries is certainly good for world innovation, but for individual players it assumes at times the nature of a race that only a few can win, if at all. We know very

little about this brave new global world, we do not possess enough data, our models are not yet tailored to fit the bare contours of these evolving phenomena, and hence can offer little help for framing policies. Again, much more research on these issues is badly needed.

## 5 Innovation Policy in the Context of Development

The N-A paradigm refers implicitly to a developed economy, and therefore innovation entails the production of new knowledge *for the world*. Not so for developing countries, where issues of transfer, imitation, diffusion, “new for the country” (or for the region, or for the firm) are as, if not more, important. In fact, innovation for development should be construed as a broad notion that includes widely distributed innovations of all stripes, both in products and in processes, generated by rank and file workers as much as by R&D labs. Furthermore, the economic rationale for government support of R&D needs to be adapted to the economic environment of developing countries, the notion of spillovers should be reexamined in view of globalization, and the same goes for the working of General Purpose Technologies (GPTs). The Israeli economy offers a fascinating illustration of extraordinary success in innovation, particularly in information and communications technology (ICT), yet the benefits from the high tech sector eluded the rest of the economy, giving rise to a “dual economy.” Understanding this outcome provides valuable insights for the design of growth-promoting innovation policies.

## 6 A Call for Policy-Oriented Research

The common thread that runs through the issues just discussed is the acute need for much more policy-oriented research in the area of innovation. How are we faring in that respect? How relevant is ongoing economic research in this area for today’s and tomorrow’s innovation policy? I must confess that I changed my mind in this respect in the course of the conference: having arrived with a low prior, I realized that there is quite a lot going on that may be relevant for economic policy, if still mostly embryonic. That is encouraging but limited, because the prevalent perception among many of our peers is still that policy-oriented research is second rate, and is looked down upon, particularly when it comes to promotion decisions.

We should recall that in the life sciences what motivates most research is the quest to find cures to disease, a fact that is widely appreciated and heralded as a beacon of science policy. In economics, by contrast, we seem to be ashamed by the explicit quest for better policies, for curing of economic or social diseases. Let me argue that being motivated by true policy issues may bring us to push the frontiers of economic knowledge no less than being

motivated by the elegance of formal models, or the degree of sophistication of stereotyped economic agents. Thus, I want to encourage all of us to go for it, to assume responsibility, and not leave policy making in the hands of bureaucrats, only to self-congratulate ourselves from the safety of ivory tower for knowing better . . . we do not. During the conference I partially recovered my faith in the economics profession, please help me turn into a true believer.