Access in the economics of knowledge

The early literature on the economics of science and technology, and particularly on its relationship with economic growth, rested on the assumption that knowledge flows freely and completely among all economic agents, and that these agents are at all times ready to use the best of that knowledge in their economic endeavours. Once limitations to the flows of technology with commercial value were recognized, a dichotomy between science and technology was usually established. But the assumption that scientific knowledge flows freely and fully is often maintained, on the basis that the reward structure of scientific activities ensures both the willingness to publicize scientific knowledge and the readiness of the entire scientific community and of the public to appropriate and use this knowledge. Of course, the new economics of science has been an exception to this rule, and has gone into great detail into analyzing the economic implications of the complex processes of knowledge diffusion.

Information technology, on the other hand, has greatly strengthened the possibilities of communication among scientists, particularly when they are in the same discipline or field. But for some years now, the simple availability of information technologies has shown to be insufficient to guarantee proper diffusjion of scientific knowledge accross society, and accross societies in modern world. Economic as well as institutional factors, sometimes deeply entrenched in the culture of communities and societies, persistently block universal access to the New Atlantis. The secrecy surrounding the House of Salomon, both in Bacon’s utopia and in the modern world of virtual science, is in striking
contrast with conventional economic and sociological wisdom calling for a free flow of scientific knowledge.

Economic and institutional barriers to knowledge-access are of different kinds. Besides the most obvious communication-infrastructure limitations, the high costs of the most efficient TCI technologies, and the inability of most media to transmit the tacit component of knowledge, some are related to intellectual property institutions; others, to the readiness of receptors of knowledge (the level and type of education they have received); there are obstacles that have to do with the organizational complexity of scientific communities, for instance the explicit and implicit rewards to collaboration, and with the governance structures of scientific institutions; finally, it is important to keep in mind that minute events, like the occasional departure of key members of a research team – perhaps determined by (macro) economic and demographic conditions – affect the ability of research teams or laboratories to capture and, most importantly, to maintain continuous inflows and outflows of knowledge.

Components of knowledge and collaboration

Perhaps the most striking experiment one could think of a virtual team creating and devicing a knowledge product, is a theater performance that recently showed in Mimos’99, at the French city of Périgueux. Two very experienced actresses, one based in Britain and the other in Australia, using also an outside director, deviced their play during expensive long distance calls between continents. According to the reviewer, the show introduced two characters that had suposedly lived for many years in the same room. They had created a series of rituals for themselves, to compensate for their lack of knowledge of the outside world. Despite the experience of the actresses and the care to prepare their play, the show received what commentators called “a surprisingly hostile reception”.

This example is particularly useful to indicate the kind of knowledge that it is not easy to share in distance collaboration. First, let’s remark that this was the case of a mime show, not of a text-centered (codified) play. Second, the example does not refer to individual performances but to “rituals” (one could read “local science conventions”) that are built between actors or actresses over some time period. Third, both actresses and their outside director were very experienced and competent, but this was no obstacle for their initial failure. The account of the show continues by saying: “By the second performance, however, technical glitches had been ironed out and (the actresses) declared the show a success”. This tells another lesson about what could happen with virtual labs. In some cases, provided there is a large body of common ground knowledge, relatively short contacts may be sufficient to share the tacit elements which are necessary to complete a satisficing collaboration process.

In the case of science, further issues arise, beyond those that are present in the dramatic arts. One common form of validation of a scientific result is the reproducibility of its experimental component. The reproducibility requirement may be interpreted as the

\[ ^3 \text{Total Theatre, III, 1999, 8-9.} \]
provision by scientific communities that induces full codification, besides the simple validation of the experimental result. There are instances where important results in modern science have not fully met the condition of full codification, sometimes because the manipulation knowledge is unarticulable, sometimes because research laboratories jealously guard secret over certain techniques as a means to ensure a competitive advantage, a situation considered to break Mertonian ethics, but nonetheless increasingly observed in scientific activities.

Another specific feature of scientific as well as technological activities, that make them different from art works, results when different research groups look for the same result: the cure of a given illness, the proof of a given conjecture, or any other result that can be pre-defined in relatively standardized terms. In such a situation, neither market incentives granting a monopoly for the commercial exploitation of the knowledge produced nor Mertonian incentives guarantee stable equilibria and overall social efficiency in the allocation of resources to knowledge production.

This discussion has identified three arguments in favor of promoting cooperation among scientific research laboratories: (1) the importance of tacit knowledge and the benefits for society resulting from sharing the tacit components of knowledge in research activities; (2) the possibility of improving reproducibility without resorting to an expensive process of codification, and (3) the failure of competition incentives to guarantee stable equilibria and overall efficiency when the expected results of competing scientific activities converge.

Also, it has pointed out several access difficulties in bringing about a successful cooperation: (1) it is not easy to ensure successful scientific cooperation among teams located at several thousand miles, unless a very expensive virtual lab infrastructure is viable and put into place; (2) incentives necessary to ensure cooperation among scientists may be hard to devise, even when scientists are driven by the pure ethics of Mertonian scientific competition rather than by commercial interests ruling the world of technology; (3) short exchanges for the purpose of ensuring the successful reproduction of an experiment may not be sufficient to allow the transmission of all necessary tacit knowledge.

Another consideration is that the transmission of knowledge, especially when it is tacit knowledge, presupposes the previous initiation of the receptor, through a formal process of disciplinary education and more specific training. Only when a tacit code that serves a

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4 As an example, an important debate has followed difficulties by other laboratories in the reproduction of synthetic malaria vaccine experiments by Colombia’s Institute of Inmunology.
5 In the sense of David, Cowan and Foray (1999).
common knowledge basis exists between transmitter and receptor will it be possible to grasp the tacit knowledge-content which is necessary.

*Intellectual property, access to knowledge and collaboration*

The existence of social institutions protecting intellectual property over technology through patents was originally a clear incentive to publicize knowledge. Its commercial exploitation is granted to the creator in exchange for its publicity and availability to other creators of knowledge who can build on that knowledge. One thing is to exclude from access to knowledge through non-disclosure and another to prevent others from directly obtaining rents from it, while being forced to disclose. However, in recent years, the use of the patent system has become an arena for playing strategies preventing full disclosure. This prevents scientists from using a large portion of the stock of social knowledge as an input for their scientific research. On the other hand, creators of knowledge may choose to keep it secret. It is interesting to observe that a strong trade secret law may reduce the attractiveness of the patent system. Conversely, a weaker trade secret institution may promote a wider diffusion of knowledge, by driving innovators towards the use of the patent system. This is an instance where the coexistence of different property rights leads to the paradox that weakening a property right may be in the benefit of society, because it drives agents towards the use of another property right (a patent) that forces disclosure and the ensuing positive externalities for knowledge production by others.

*Common knowledge and collaboration*

Different accounts of experiments in scientific collaboration and surveys presented at Laxenburg II have stressed the importance of “common grounds” for their success. A common basis of knowledge seems to be necessary for the transmission of both codified and tacit knowledge among collaborating teams. What it seems important to ask is what kind of knowledge is necessary to reduce the costs of collaboration between two or more research teams.

To answer this question, it is useful to make a distinction between two types of knowledge, as is done in recent work: a collection of pairs of situations and corresponding successful strategies, and the procedures necessary to search for strategies which are adequate to specific situations. Knowledge necessary for productive activities

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12 As was proved in Forero (1996).
or for scientific research is not only the information about the world and about successful ways of dealing with specific situations. The ability to socialize knowledge, versatility, creativity and other attributes are instrumental to successful collaboration and have an economic value in certain economic circumstances.13

The landscape of science in the era of collaboratories

With the coming of collaboratories, what is the map of scientific activity to be expected for the near future?

One frequently hears statements implying that all traditional laboratories are at this time in the process of spontaneously converting into collaboratories, as a result of the forces of progress and natural selection. Actually, this is not the case. What one could expect instead, if one tries to advance an evolutionary approach into this question, is the coexistence of three relatively stable polar structures, each reinforced by its surrounding local scenario, and connected among them:

a. Collaboratories.
b. Traditional laboratories (or research teams), relating to other labs mainly through competition for funds within the priority-rule governed scientific arena, and with some informal networking relationships with other groups.
c. Relatively isolated laboratories, connected to the world scientific community in their discipline only through journals and congresses, and playing a relatively passive role in the advancement of knowledge. Informal networking is relatively weak for these groups. Most developing-country laboratories fall within this category14 though there are remarkable exceptions.

Several reasons explain why these three kinds of labs may coexist – despite the great variance in their apparent productivity: (a) rather than being governed by markets, they are governed and financed by hierarchies; (b) the unique character of each knowledge product, and (c) large differences among local social environments and the kind of relationship they hold with society.

The main point to make in this prospective exercise is that these three polar types of laboratories are sustained by self-reinforcing mechanisms. The least stable of these structures is the collaboratory, because of its high costs, the uncertainty about its benefits, and the conflicts that may arise between their cooperative nature and the competitive character of the priority rule15. Therefore, it is to be expected that it takes special efforts, policies and perhaps strong external incentives to displace a certain research unit from one sub-scenario to the other.

13 See Forero and Riaga (1999). The distinction between two types of knowledge used by that work to analyze the attributes of knowledge follows Newell (1992), Newell and Simon (1956) and Pirolli (1996).
14 The dynamics leading to the situation of these groups was sketched in Forero (1997), Laxenburg I.
15 Under priority rule, their stability is comparable to that of a prisoner’s dilemma. The folk theorem may apply in a dynamic, repetitive situation. Defection, however, may occur sequentially and still there may be incentives for further participation in collaborative projects, as suggested by P. David. This calls for devicing mechanisms with the intervention of a third party or enforceable contracts among collaborators.
The present structure of rewards of scientific communities (based on priority, which tends to reinforce competition rather than collaboration) is definitely not sufficient to ensure a massive movement from traditional labs to collaboratories. The intervention of sources of finance for science should play a non-neutral role to ensure a more rapid movement towards collaborative science. Besides that, scientific communities should device ways of rewarding and give recognition to the role played by collaboration pioneers (“champions” or “evangelists”, as they have been called). For that, one could envisage the revision of the discipline-specific rules of coauthorship, though this is not a change that can be expected in the short term, or changes in the form and extent of acknowledgements might perhaps be devided. Summing up, there are unavoidable transaction costs associated with the change towards collaborative science and virtual laboratories. On the other hand, it is not clear that communities will find this collaboration advantageous in all fields of science.

In the case of isolated laboratories, further intervention has to occur, particularly when they are located in developing countries. The appearance of collaborative science in the more advanced countries may facilitate international connectivity of small laboratories in developing countries, as the experience of Red Caldas\textsuperscript{16} and other networking initiatives by developing countries has shown. But only if explicit policies, carefully designed specific financial incentives and recognition systems are adopted by developing-country governments and other sources of finance of their scientific activity, will there be a favourable scenario for international collaboration and the opening of their scientific activity.

\textsuperscript{16} See Forero (1997), Laxenburg I.