INTERNATIONAL DIFFUSION OF TECHNOLOGY KNOWLEDGE

Comment: Luc Soete

David Audretsch's paper provides a broad, highly personalised overview of a large body of literature brought together under the "international technology diffusion title" and encompassing such diversified fields and topics as diffusion theory, technological paradigms, national systems of innovation, European competitiveness and Germany's Standortkrise.

In a typical Audretsch style, the overview presented is selective, provocative, nicely written and full of anecdotal detail. After criticizing the diffusion literature for focussing too much on the diffusion of particular technological rather than organisational innovations, the author briefly describes most of the traditional early diffusion literature. I fully sympathize with the author's difficulty in having to summarize this vast literature in a couple of pages. However, the overview could have gained by focusing on some of the more recent diffusion literature. As it stands the overview is really incomplete, both in terms of reviewing the most important contributors and in providing a full overview of the many directions in which progress has been made over the last thirty years. Thus, the omission of Paul David in this overview is not just striking, it has also resulted in an underemphasis of some of the recent contributions in this area focusing amongst others on the relationship between various diffusion models (semilogistic, probit, etc.), market structure, profitability and learning.

More substantially though this traditional view of diffusion has led the author to stick to a rather linear product life cycle view of the innovation process, starting with basic research and ending up somewhere with a new commercial product or process. Most researchers working in the innovation and diffusion area today would probably strongly disagree with this view. And I guess that even Audretsch himself is probably more inclined to see his ideas about technological trajectories and paradigms fit much better the more systemic approach to the innovation and diffusion process. Let me highlight briefly, why the latter approach is much more appropriate.

First of all, there is of course the view that throughout the diffusion process, there is a continuous feedback with research, with basic science, and besides that the diffusion process is one of continuous incremental improvements to the particular initial product. In other words, there is a learning process taking place. That learning process can more and more resemble an accumulation process of a whole set of codified and tacit pieces of knowledge which are converging and therefore create new forms of tacit knowledge.
Secondly, there is a crucial relationship between "producers" of the new technology and users. During the diffusion process the crucial feedback from the users of the new technology, of the new product or new production process is essential in the further improvements to that product or to the process. Again I'm sure that Audretsch knows this literature, such as the studies of Lundvall et al. on the Danish diary industry, whereby diary machine producers interacted systematically with diary producers to continuously improve their products. There are lots of similar studies done at the sectoral level, e.g. at SPRU (Keith Pavitt built his by now famous taxonomy precisely on such studies) illustrating this continuous interaction between users and producers. This literature explains actually very well some of the locational features emphasized by Audretsch -- the sectoral clustering; the sort of "systemic" view of diffusion behind this process; the crucial importance of incremental, accumulated improvements along the diffusion process; etc. -- all features characteristic of a much more Schumpeterian view of diffusion.

My other criticism is that the use of individual cases, more correctly: cases of "individuals", needs to be substantiated to a much larger extent. There are of course many interesting cases useful in terms of the description of the details of what happened, but there are also all the unknown stories of where firms pursue correctly new innovation areas. Much more empirical work is needed before one can draw conclusions from such "individuals" case studies. I refer amongst others to a recent NBER paper on the location of new biotechnology firms and the particular role played by "star" scientists in the creation of such new high tech firms. So while individuals do matter, there is a strong need for more systematic empirical research in this area, going beyond the simple anecdotal description of "individuals" cases.

Another major criticism on Audretsch's paper is the particular by vague description of the notion of "paradigm shift". Some of the people participating in this conference have also used this concept but with a very different meaning. Frieder Meyer-Krahmer in a recent paper refers to a "paradigm shift" in terms of the nature of technologies shifting to become much more science based, much more complex, multidisciplinary, etc. I know e.g. that Sylvia Ostry uses the concept of paradigm shift in terms of the shift towards a service economy, information society. So I think it is essential for Audretsch to elaborate and be much more specific about this concept.

Let me conclude with two comments, elaborations one may say on Audretsch's paper.

First, I would strongly argue that one of the underlying processes of a possible paradigm shift towards global networking of information, is closely related to the tremendous increase in the codification of knowledge due to information and
communication technology. The latter has increased enormously the possibilities to have worldwide access to codified knowledge and thus appears at least at first sight to have reduced the amount of tacit information. One may think of the concept as explained by Richard Nelson or Giovanni Dosi: "you cannot be a good cook by just reading a cook book". Well, if one looks at the increase in terms of audio and visual information and the continuous additional ways in which more information is being codified, my conviction is that one certainly can increase one's performance as a cook. You might never become a Bocuse but you certainly will -- without actually having spent too much time in practicing and learning -- through the increase of that part of codified knowledge giving you e.g. visual information on the sort and quantity of all the ingredients, what sort of "impact" the mixing of such ingredients may have, illustrating how other people do it, improve your "cooking" ability. Of course, the value of the remaining amount of tacit knowledge will relatively speaking increase and become even more important. But I still would argue that it is the incredible increase in the amount of information which can be processed, codified and internationally traded and exchanged which is the essential feature behind the present paradigm "shift".

Let me then as final comment, raise some more speculative questions, inspired by Audretsch's paper, looking more at the European side than the German side of the issue. First, on the basis of the indicators we have calculated for the European Commission (the so-called European Science and Technology Indicators Report), the evidence is that if you want to talk about crisis, there is possibly a real crisis in Japan. In Japan the R&D indicators, the patenting indicators for the first time but many other economic indicators, too, show a significant decline particularly in the high tech areas and the technology-intensive sectors. Whether this is a cyclical or structural phenomenon is too early to answer. Secondly, if you look at the indicators of countries in the EU or Germany, there is indeed convergence of indicators in terms of scientific publications, patent publications or R&D efforts pointing to remaining strengths in particular but closely related sectors. Thus, there is a traditional weakness in Europe, and in Germany in particular, in the information and communications sectors. Let me though emphasize that what is missing in this sort of indicators analysis is precisely the link between the micro diffusion part and the macro or sectoral evidence.

This is where I think one could either go in the direction which Rivera-Batiz gave us in his presentation which is: argue that the R&D decline in Europe in some sectors is closely related to shifts, trade-offs between sectoral shifts in terms of human capital, e.g. in the information and communication technology sectors. Maybe this has been enforced by technology policies which have focused too much on traditional ways in which to strengthen the R&D basis and not on the particular features which had more to do with
the shift towards the information service sectors and the importance of new emerging activities. One could also go the other way which is more in an institutional direction. Do we have the appropriate institutions in Europe or are they sufficiently prone to assist in this sort of shift. Let me just refer to a paper I am writing with Richard Nelson in which we start from the argument that new growth theory gives us empirically a major research paradox. That is to say that regarding the research part where one would assume that "ideas", that research would lead to the highest externalities or the largest effects in terms of increases in growth, i.e. the basic or fundamental research part, there appears e.g. in a cross-country setting a negative rather than positive relationship to actual growth performance. This apparent research paradox does not only question the empirical support for "pure" new growth theory, it also questions the traditional premises of government policy in the area, supporting generally speaking precisely that part of research which seems to be the most basic, the most fundamentally related to new ideas. This paradox highlights precisely the crucial part institutions have to play in increasing the efficiency of the science and technology system. Whether this leads to arguments about the need for international corporate governance or to criticism of particular German institutions which might have failed to make the necessary shift, is then the policy challenge to which Audretsch's paper has certainly given much food for thought.