SIEPR Discussion Paper No. 07-33

"Only Connect": Academic-Business Research Collaborations and the Formation of Ecologies of Innovation

By
Paul A. David,
Stanford University and Oxford Internet Institute
and
J. Stanley Metcalfe
Manchester Institute of Innovation Research,
University of Manchester

January 2008

Stanford Institute for Economic Policy Research
Stanford University
Stanford, CA 94305
(650) 725-1874

"ONLY CONNECT": ACADEMIC-BUSINESS RESEARCH COLLABORATIONS AND THE FORMATION OF ECOLOGIES OF INNOVATION*

Paul A. David* and J. Stanley Metcalfe**

**Stanford University and Oxford Internet Institute*
***Manchester Institute of Innovation Research, University of Manchester*

Final draft: January 28th, 2008

ABSTRACT

Public and private policy for the European Research Area – as elsewhere --has an important role to play in fostering and maintaining the richness and diversity of this region's "innovation ecology". This is especially so in respect to the formation and reconfiguration of information connections among the region's business and public organizations and institutions so as to promote higher rates of innovation. But a fresh look, and "rethink" within an explicit "systems" or organizational ecology framework is in order, because some of the main institutional innovations that have been promoted with a view to enhancing the exploitation of university research are do not seem to be the most beneficial ways of ensuring that knowledge which is created in academic research communities is made available to be translated into greater economic wealth. It is not sensible for policy-makers to continue trying to overcome the barriers to connecting publicly funded research conducted in the universities with commercially-oriented R&D and innovation, by having academic institutions become dependent upon commercialization of research findings and, hence being induced to behave as proprietary performers of R&D. Adding to the existing pressures on academic communities and their leaders to take on new and different missions, for which their historical evolution and specialized characteristics have not equipped them, runs the risk of damaging their ability to fulfill critical functions that no other organizations in the society are prepared to perform will comparable effectiveness. Vigorous pursuit of that strategy would jeopardize the open science arrangements that are more effective for the conduct of fundamental, exploratory research – a function that must be fulfilled by some institution if a basis for long-run productivity growth is to be sustained.

Contact Author: Paul A. David, Department of Economics, Stanford University, Stanford CA 94305-6072. Email: pad@stanford.edu

1. University Patenting for Technology Transfer— Miraculous or Mistaken Movement?

The international movement to emulate the U.S. institutional reforms of the early 1980's that gave universities and publicly funded technology research organizations the right (rather than a privilege granted by a sponsoring agency) to own and derive income from the commercialization of IP based on their researchers' inventions, has developed remarkable momentum since its inception at the end of the 1990s [see e.g., Mowery and Sampat (2005)]. The process of change and adaptation that was thereby set in motion among the EU member states has not yielded the dramatic effects upon innovation and employment growth in Europe that had been promised by who enthusiastically prescribed a dose of "the Bayh-Dole solution" for the region's sluggish economies.

But such expectations were at best unrealistic, and in too many instances stemmed from contemporary European observers mistaken suppositions regarding the sources of the revival of productivity growth and the "information technology" investment boom in the American economy during the late 1990's; and more widely shared misapprehensions regarding the fundamental factors that were responsible for the rising frequency with which patents applications filed at the USPTO during the 1980's and 1990's were citing scientific papers academic authors.[1]

The movement to promote "technology transfers" from universities to industry through the medium of patent licensing was fueled by a widespread supposition that European academic research was dangerously disconnected from the processes of private sector innovation. This belief rested largely on the observation at the turn of the century that the regions' universities were not extensively involved as corporate entities in filing applications for patents, and negotiating the terms on which the inventions could be commercially exploited (whether by being "worked" or not) business licensees. The obvious contrast was that drawn with contemporary scene in the U.S. during the frenzied era of the dot-com and biogenetics boom, where research universities' patenting and the licensing of technology to venture-capital fueled "start-ups" was rapidly growing. Whatever the accuracy of European perceptions about the realities of events taking place on the far side of the Atlantic Ocean, it has become clear that there was a serious misconception of the realities of university-industry technology transfers closer to home. Several of recent studies have revealed, however belatedly that much of the university research leading to patents in Europe does not show up readily in the statistics, because private firms rather than the universities themselves apply for the patent.[2]

---

[1] It is unnecessary to review the details of these misunderstandings, which are discussed in P. A. David, "Innovation and Europe's academic institutions -- second thoughts about embracing the Bayh-Dole regime," in *Perspectives on Innovation*, F. Malerba and S. Brusoni, eds. Cambridge: Cambridge University Press, 2007. [Available as SIEPR Policy Paper 04-027, May 2005) [Available at: http://siepr.stanford.edu/papers/pdf/04-27.html.] For a comparison of the questionable effects of Bayh-Dole on the licensing activities of three major USA universities see Mowery *et al.*, 2004.

[2] M. Balconi, S. Breschi, and F. Lissoni, "Networks of inventors and the role of academia: An exploration of Italian patent data," *Research Policy*, 33(1), 2004: pp.127-45; A. Geuna and L. Nesta, "University patenting

The impression that university professors in the physical sciences and engineering were not engaged in patent-worthy inventive activities whose results were of interest to industrial firms was firmly dispelled for the case of Italy by a study of the identities of inventors named in patents issued by the European Patent office during 1978-99: Balconi et al (2004: Table 3) found that for many research areas the Italian academic *inventors* of those patents formed quite a sizeable share of all the professors working in those fields on the faculties of Italy's universities and polytechnics at the close of that period.[3] In 11 of the 20 research fields studied, 13.9 percent or more of the professors working in the field were identified as the inventor of EPO patents issued for in the corresponding field; in the case of quite a few specialty areas such as mechanical and chemical bioengineering, and industrial and materials chemistry, the corresponding proportions were much higher – ranging from one-third to one-half. The transfer of the ownership of those patents to industrial firms was the norm in Italy, as was the case elsewhere in Western Europe during this era.[4] According to Crespi, Geuna and Verspargen (2006), about 80 percent of the EPO patents with at least one academic inventor are not owned by the university, which means that no statistical indication a university involvement in the technology's creation would be found by studying the patent office records.

Thus, the appearance of a lack of "university patents" in Europe must be understood to be a lack of *university-owned* patents, and not necessarily indicative of any dearth of *university-invented* patents. Once the data are corrected to take into account of the different ownership structure in Europe and the U.S., very simple calculations made by Crespi, Geuna and Verspagen (2006) indicate the European academic system seems to perform considerably better than was formerly believed to be the case: indeed, the patenting output of European universities' lags behind only one among the US universities – and in that exception the difference was quite marginal.

---

and its effects on academic research: The emerging European evidence," *Research Policy*, 35 (June-July), 2006 [Special Issue on Property and the Pursuit Issues Affecting Scientific Research, eds., P. A. David and B. H. Hall]; G. A. Crespi, A. Geuna, and B.Verspagen, "University IPRs and Knowledge Transfer. Is the IPR ownership model more efficient?" Presented to the 6th Annual Roundtable of Engineering Research, Georgia Tech College of Management, 1-3 December 2006 [available at: http://mgt.gatech.edu/news_room/news/2006/reer/files/reer_university_iprs.pdf].

[3] The statistics presented by Balconi et al (2004) in Table 3 refer to 20 specific science and engineering research fields in which at least 20 academic inventors (of all nationalities) could be observed in the EPO patent data for the years 1978-1999. The proportions referred in the following text pertain to Italian academic inventors as a fraction of total faculty enrolments in the corresponding fields at Italian universities and polytechnics on 31 October 2000.

[4] Paradoxically, this was the practice despite the fact that at that time Italian universities had titular rights to own the patents filed by their employees, which was anomalous in the context of the German, Dutch and other national universities at the time; the practice in Italy, removed the anomaly by permitting their professors to assign the rights directly to industrial companies – a practice that subsequently was ratified by a change in the Italian law. While that change seemed, quixotically to run against the stream of Bayh-Dole inspired "reforms" that were underway in other nation's university systems at the time, giving patent rights formerly held as the professors' prerogatives, to their employers. Operationally, however, the Italian reform was more in accord with the intention of facilitating the transfer of new technologies to industry, legalizing the way it had previously been done.

If there are grounds for suspecting that it may not really have been necessary for Europe to embrace the Bayh-Dole regime's approach to effecting "technology transfers" from academic labs to industrial firms, there also are doubts as to whether the likelihood of innovative success ensuing from such transactions is raised by having university's rather than firms own the patents on academic inventions. There are theoretical arguments about this, pro and con, because the arguments turn essential upon the comparative strength of opposing effects: are firms likely to make a better job of the innovation process because they have greater control over the development of their own inventions?, or is it less likely that viable academic inventions will be shelved if the inventor's institution retains control of the patent and has incentives to find a way of licensing it to a company that will generate royalty earnings by direct exploitation?

Since the matter is therefore an empirical question, it is fortunate that Crespi, Geuna and Verspargen (2006) recently have carried out a statistical analysis of the effects of university ownership on the rate of commercial application (diffusion) of a patent, and on the commercial value of a patent, based upon the experience of European academic inventions for which patents were issued by the EPO.[5] Their analysis controls for the different (ex ante observed) characteristics of university owned and non-university owned patents, and hence is in accordance with the theory that suggests that university ownership is the endogenous outcome of a bargaining game. Both before and after controlling for such differences between patents, they find no statistically significant effects of university ownership of patents. The only significant (positive) effect reported is that university-owned patents are more often licensed out, but this does not lead to an overall increase in the rate of commercial use. Hence the authors conclude that they can find no evidence of "market failure" that would call for additional legislation in order to make university patenting more attractive in Europe. Their suggestion that whether or not universities own commercially interesting patents resulting from their research appears not to matter, being adjusted in the terms of the inter-organizational bargaining process, is an interpretation of the findings that should gratify admirers of the Coase Theorem's assertion that the locus of ownership of valuable property does not carry efficiency implications where transactions costs are not very high.

Nonetheless, even though impelled by misconceptions of the realities both in the U.S. and in Europe, there is now a general sense that the shock to the administrative system into which Europe's universities had settled in the era following the rapid post-World War II proliferation of new institutional foundations, has been on balance salutary in its effects for the longer term. Perhaps that is so. It has encouraged fresh thinking about the potential payoffs of publicly funded research in terms of commercial innovation in small and medium size industries, and of the support that applied research in areas where new science might spawn new technologies of interest to major new industries. It has precipitated and legitimized the assertion of university rights to ownership of intellectual

[5] G. A. Crespi, A. Geuna, and B.Verspagen, "University IPRs and Knowledge Transfer. Is the IPR ownership model more efficient?" Presented to the 6th Annual Roundtable of Engineering Research, Georgia Tech College of Management, 1-3 December 2006. [Available at: http://mgt.gatech.edu/news_room/news/2006/reer/files/reer_university_iprs.pdf.]

property vis-à-vis the claims of their employees –an alteration in institutional norms that had occurred almost universally in the U.S. before the 1970s. More significantly, perhaps, it had the effect of encouraging a general re-examination of university regulations affecting the activities of academic researchers in Europe. The liberalization -- for the benefit of universities -- of many rules that had been imposed uniformly on state institutions and their employees, in turn, has opened the way to a broader consideration of the need for greater institutional independence and autonomy, and brought more realistic attention to the creation of incentive mechanisms that would redirect individual activities and raise productivity among those who worked within these organizations.[6]

2. Productive Shocks and Lasting Problematic Tensions

These have been important steps toward the flexibility needed for R&D collaborations throughout the ERA, even though a considerable distance remains to be traveled by the respective national government authorities along the path towards granting greater autonomy for to their institutions; and also by consortia and regional coalitions of the institutions themselves to remove the impediments to collaboration and inter-university mobility of personnel that continues to fragment the European market for academic science and engineering researchers.

Furthermore, although European governments have not hesitated to urge business corporations to accept the necessity of investments in "organizational re-engineering" to take full advantage of new technologies and consequent new ways of working, they have not been so quick to put this good advice into practice "closer to home" -- when urging "modernization" upon their respective educational and research institutions. Yet it is now more widely recognized that the "modernizing" of university governance and management is not a costless process, and, like "business re-engineering", requires up-front incremental expenditures to effect the transformations that are expected to yield sustainable future gains in the efficiency of resource use.

There is thus an obvious tension between two key assertions about university-business interactions in many current policy recommendations, and in the programs that seek to respond to their advice. Insistence giving priority to "market-driven" technology transfers - based upon the licensing or direct exploitation of intellectual property arising from

---

[6] In this regard it is significant that the latter considerations led the Italian government to award ownership rights in patents to their faculty employees, whereas the industrial treatment of "work for hire" by employed inventors was applied to university faculty by all the other European states. Thus, in Denmark, public research organizations including universities were given the rights to all inventions funded by the Ministry of Research and Technology (in 1999); French legislation authorized the creation of TTO's at universities (in 1999), and university and PRO assertion of rights to employee inventions was "recommended" by the Ministry of Research (in 2001); the "professor's privilege" was removed in Germany by the Ministry of Science and Education (in 2002); in Austria, Ireland, Spain, and other European countries the employment laws have been altered to removed "professor's exemption" from the assignment to employers of the IP rights to the inventions of their employees. See OECD, Turning Science into Business: Patenting and Licensing at Public Research Organizations, Paris: OECD; D. C. Mowery and B. N. Sampat, " Bayh-Dole Act of 1980 and University-Industry Technology Transfer: A Model for Other OECD Governments?" *Journ. Technology Transfer*, 20(1-2), 2005: pp. 1115-127.

university research –creates impediments to inter-organizational collaboration, and, at very least tends to inhibit the recommendation that universities strive to develop more frequent inter-personal collaborative contacts to encourage exchange of scientific and technological information with industry. That this tension remained unresolved is not surprising, but that continued to pass without much comment in policy circles for so long a time was nonetheless unfortunate.

Most welcome, therefore, are the growing signs of a shift of thinking in Europe that is evidenced in such statements as the one below, in which the view expressed by EC Staff Working Document [COM(2007), 161/2 :p.52] is in harmony with that in the 2005 report by the Forum on University-based Research:

> From a societal perspective, more will be gained by letting our universities excel in knowledge creation while encouraging closer links with the rest of society, than by insisting that they should fund themselves mainly through commercializing their knowledge.

This may intimate that the orientation of policy development for the ERA, particularly that aiming to "strengthen the link between the public research base and industry,"[7] is now moving into closer alignment with what appears to be the emergent trend in industry-university collaboration in the U.S. The latter, however, is not another new institutional model. Quite the opposite, in fact, as the signs are indicating a growing movement to recover a mode of interaction that seemed to have been all but lost in the post-Bayh-Dole era. One harbinger of this trend-reversal might be seen in the recently announced Open Collaborative Research Program, under which I.B.M., Hewlett-Packard, Intel, and Cisco Systems and seven U.S. universities have agreed to embark on a series of collaborative software research undertakings in areas such as privacy, security and medical decision-making. The intriguing feature the agreement is the parties' commitment to make their research results freely and publicly available. Their avowed purpose in this is to able to begin cooperative work, by freeing themselves from the lengthy delays and costly, frustrating negotiations over IP rights that proposals for such collaborative projects typically encounter.[8]

This development reflects a growing sense in some corporate and university circles during the past five year that the Bayh-Dole legislation had allowed (and possibly encouraged) too great a swing of the pendulum towards intellectual property protection as the key to appropriating economic returns from public and private R&D investments alike; that the vigorous assertion of IP rights was being carried too far, so that it was impeding the

---

[7] The quoted phrase is the single most frequently cited national policy development among those listed in a country-by-country summary of the 25 EU member states' "National policies toward the Barcelona Objective," in European Commission, *Investing in research: an action plan for Europe*, Brussels EUR 20804 [COM92003) 226 final], Table 2.1, pp. 29ff.

[8] See Stever Lohr, "I.B.M. and University Plan Collaboration," *New York Times*, 14 December, 2006. [Available at: http://www.nytimes.com/2006/12/14/technology/14blue.html.] The universities involved are U.C. Berkeley, Carnegie Mellon, Columbia University, U.C. Davis, Georgia Institute of Technology, Purdue University and Rutgers University.

arrangement of inter-organization collaborations involving researchers the private and publicly-funded spheres. As Stuart Feldman, I.B.M.'s vice-president for computer science, explained to the *NYTimes* reporter: **"**Universities have made life increasingly difficult to do research with them because of all the contractual issues around intellectual property….We would like the universities to open up again;" a computer scientist Purdue University echoed: "Universities want to protect their intellectual property but more and more see the importance of collaboration [with industry]."

Evidence of the effects of Bayh-Dole inspired legislation in the EU is beginning to appear and points to the negative effects that it may have. Thus a recent study has investigated the effect of the January 2000 Danish Law on University Patenting and found that it lead to a reduction in academic industry collaboration within Denmark[9]. This law, which transferred patent rights to the university employer of inventions produced by Danish university scientists acting alone or in collaboration with industry, had the further effect of increasing collaboration between Danish biotech firms and scientists working outside of Denmark. It is clear that the transfer of instituted rules from the USA to Europe is not to be treated lightly; their effects in different regimes may not correlate at all well.

How widely such views are shared, and how potent they may become altering the modus of industry university interactions that enhance "technology knowledge transfers", as distinguished from "technology ownership transfers," remains to seen. It is still much too early to venture speculations as to whether other institutions will follow, and it seems unlikely that those with substantial research programs in the life sciences and portfolios of biotechnology and medical device patents will find themselves impelled to do by the enthusiasm for such open collaboration agreements on the part of drug development firms and major pharmaceutical manufacturers.

From the societal viewpoint, the issue of whether IPR protection is getting in the way of the formation of fruitful collaborations between industry and university researchers is fundamental a question about the conditions that will maximize the marginal social rate of return on public investment in exploratory research, by making it more attractive for R&D-intensive firms with interests and capabilities in the potential commercial applications, to collaborate with publicly-funded academic research groups – in the hope of subsequently exploiting the knowledge-base thereby created. This issue is not un-related to an important aspect of the concerns that have been raised in regard to potential "anti-commons effects" of the academic patenting of research tools, and the resulting impediments to downstream R&D investment that are created not only by "blocking patents", but by "patent thickets" formed by a multiplicity of IP ownership rights that are quite likely to be distributed among different PROs. The latter would contribute to prospects of "royalty stacking" that would reduce the prospective revenues from a technically successful innovation, and to higher investment costs due to the transactions costs of conducting extensive patent searches and multiple negotiations for the rights to use the necessary set of upstream patents. It would seem possible to address the source of

[9] F. Valentin, and R.L. Jensen, 'Effects on Academia-Industry Collaboration of Extending University Property Rights', *Journal of Technology Transfer,* Vol.32, 2007: pp.251-276.

this particular problem by allowing, or indeed encouraging the cooperative formation of efficient "common –use pools" of PRO patents on complementary collections of research tools. While this would strengthen the bargaining position of the collectivity of patent-owning institutions, and it would be necessary to have supervision of the competition authorities to present abuses, it might well increase the licensing of those technologies to downstream innovators. Of course, it is a second-best solution from the societal viewpoint, as the award of ownership rights on inventions that have resulted from publicly funded academic research will result in a "deadweight loss" -- due to the effect of the licensing charges that curtail the downstream exploitation of those inventions.[10]

The specific functionality of the information-disclosure norms and social organisation of open science that until very recently, by historical standards, was strongly associated with the ethos and conduct of academic, university-based research, rests upon the greater efficacy of data and information-sharing as a basis for the cooperative, cumulative generation of eventually reliable additions to the stock of knowledge. Treating new findings as tantamount to being in the public domain fully exploits the "public goods" properties that permit data and information to be concurrently shared in use and re-used indefinitely, and thus promotes faster growth of the stock of knowledge. This contrasts with the information control and access restrictions that generally are required in order to appropriate private material benefits from the possession of (scientific and technological) knowledge. In the proprietary research regime, discoveries and inventions must either be held secret or be "protected" by gaining monopoly rights to their commercial exploitation. Otherwise, the unlimited entry of competing users could destroy the private profitability of investing in research and development.[11]

One may then say, somewhat baldly, that the regime of proprietary technology (*qua* social organisation) is conducive to the maximization of private wealth stocks that reflect current and expected future flows of economic rents (extra-normal profits). While the prospective award of exclusive "exploitation rights" have this effect by strengthening incentives for

---

[10] There was, something not so foolish, after all, in the old-fashioned idea of upstream public science "feeding" down-stream research opportunities to innovative firms. The worries that this will not happen in the area of nanotechnology (see M. A. Lemley, "Patenting Nanotechnology", October, 2005 [available at: http://siepr.stanford.edu/programs/SST_Seminars/index.html] brings home the point about the unintended consequences of the success of national policies that aimed at building a university-based research capacity in that emerging field. The idea was not to allow domestic enterprise to be blocked by fundament patents owned by other countries. That they might now be blocked by the readiness of PRO's on their home terrain seeking to exploit their control of those tools is a disconcerting thought. For points of entry into the growing economics literature on the impact of academic patenting upon exploratory research investments, the "anti-commons" question (and the ambiguities of recent empirical evidence regarding its seriousness), patent thickets, royalty stacking, and efficient IP pools, see, e.g., P, A David, "The Economic Logic of 'Open Science' and the Balance between Private Property Rights and the Public Domain in Scientific Data and Information: A Primer," in *The Role of the Public Domain in Scientific and Technical Data and Information: A National Research Council Symposium*, J. Esanu and P. F. Uhlir, eds., Washington, D.C.: Academy Press, 2003; M. A. Lemley and C. Shapiro, "Royalty Stacking and Patent Hold-up," January, 2007 [available at: http://siepr.stanford.edu/programs/SST_Seminars/index.html] .

[11] This and the following discussion draw upon P. Dasgupta and P. A. David, "Toward a New Economics of Science," *Research Policy*, vol. 23, 1994: pp. 487-521, and P. A. David, "The Economic Logic of Open Science" (2003), loc.cit.

private investments in R&D and innovative commercialization based on the new information, the restrictions that IP monopolies impose on the use of that knowledge perversely curtail the social benefits that it will yield. By contrast, because open science (*qua* social organization) calls for liberal dissemination of new information, it is more conducive to both the maximization of the rate of growth of society's stocks of reliable knowledge and to raising the marginal social rate of return from research expenditures. But it, too, is a flawed institutional mechanism: rivalries for priority in the revelation of discoveries and inventions induce the withholding of information ("temporary suspension of cooperation") among close competitors in specific areas of ongoing research. Moreover, adherents to open science's disclosure norms cannot become economically self-sustaining: being obliged to quickly disclose what they learn and thereby to relinquish control over its economic exploitation, their research requires the support of charitable patrons or public funding agencies.

The two distinctive organisational regimes thus serve quite different purposes within a complex division of creative labour, purposes that are complementary and highly fruitful when they co-exist at the macro-institutional level. This functional juxtaposition suggests a logical explanation for their co-existence, and the perpetuation of institutional and cultural separations between the communities of researchers forming 'the Republic of Science' and those who are engaged in commercially-oriented R&D conducted under proprietary rules. Yet, these alternative resource allocation mechanisms are not entirely compatible within a common institutional setting; *a fortiori,* within same project organisation there will be an unstable competitive tension between the two and the tendency is for the more fragile, cooperative micro-level arrangements and incentives to be undermined.

3. Social Interactions across Organisational Boundaries and the Facilitation of Collaborative Research

Beyond the overtly commercial and explicitly contractual interactions involving IP, whose role at the macro-system level in supporting R&D investment and innovation tends to be accorded prime place in general policy prescriptions, the importance of other channels of "interaction" with business is often stressed in discussions of what the leadership of Europe's universities should be doing in that regard. Prominent on this list are the variety of interpersonal and inter-organizational connections that bring participants in academic research into regular contact with members of the local, regional and national business communities. Under the heading "The role of the universities in promoting business-university collaboration," the *Lambert Review* (2003: p. 41), for example, remarked on the growing role that universities (in the U.K.) have taken in their cities and regions during recent decades:

> "Vice-chancellors often have links with the CEOs of major local companies, with chambers of commerce, with their development agency and with NHS Trusts and other community service providers in their region. Academics work with individual businesses through consultancy, contract or collaborative research services. University careers services co-operate with the businesses

> which wish to recruit their graduates or provide work placements for their students."

The trend toward organized institutional involvement – as distinct from personal connections between university professors and industrial and financial firms in their local -- is indeed an ongoing process for many of Europe's HEI's. But, the reader of the *Lambert Review* who was familiar with the U.S. university scene, especially that among the public (Land Grant) institutions, would be struck by its suggestion of novelty in top level administrators having links with CEOs and local business leaders, inasmuch as this would be presumed to be the case for their American counterparts.

Also noteworthy, as a reflection of the "top down" impetus for the establishment of such relationships, is the quoted passage's emphasis on the co-operation of university careers services with recruiters from business firms. At most major U.S. research universities – where the organized placement services of the professional schools, as well as those of the undergraduate colleges have long been established -- the important recruiting contacts with graduate scientists and engineers are typically arranged at the level of the individual departments, and often are linked with a variety of "industrial affiliates" programs. This is important in view of the expert screening functions that are performed for potential employers by universities' graduate educational programs and faculty supervisors. That publicly subsidized service (provided as it is without fee) is especially valuable for companies seeking promising fresh talent trained in frontier fields of science and engineering, where the firms themselves may lack the expertise, as well as the extended opportunity to observe and assess the abilities of current graduates and form contacts with those who will be seeking employment positions in the near future.[12] The formation of enduring ties for the transfer of knowledge through the movement of personnel gives business organizations access to the craft aspects of applying new techniques, contacts with new recruits' personal network of other young researchers, and an advantage in spotting exceptional capabilities to conduct high caliber research. Such ties are sustained by personal relationships with the student's professors, and strengthened by "repeat play" which tend to inhibit the latter's inclination to "over-sell" members of their current crop of Ph.D.'s and postdocs; similarly, the prospects of having to try to recruit next year from the same source works to induce the firms to be more candid in describing the nature of the employment opportunities that professors may recommend to their good students. The point here is that the direct participation of the parties, rather than institutionally provided third-party intermediation services, will generally be a requirement for successful "relationship management" in the market for young research talent.

Perhaps the greater prevalence of such arrangements that can be observed in science and engineering departments and research groups at U.S. universities can be attributed to the greater degree of autonomy that university administrations there have allowed to these

[12] The value of the screening function for employers is the other side of the coin of the "signalling" benefits that are obtained by young researcher who trained and choose to continue in post doctoral research positions in academic departments and labs where publication policies conform to open science norms of rapid and complete disclosure. On job market signalling and screening externalities in this context, see, e.g., Dasgupta and David (1994), sect.7.1, pp. 511-513.

units, permitting (and indeed providing them with initial help) them to create special programs of lectures, seminars, and gatherings of "industry associates" by soliciting and using funds contributed by the business invitees who participate as sponsors of those events. Initiatives of this kind, it must be said, are also an aspect of the traditions of local community and regional involvement that were developed in the agricultural and engineering schools of State (public land grant) universities in America. This form of direct engagement with the society beyond the precincts of the academy has been further reinforced and extended to the private HEI's in the U.S. by the generally more intense competition among them in the placement of graduating students in national and regional job markets – which is especially pronounced in the cases of the professional schools and graduate science and engineering faculties. Whatever the precise sources of these contrasts may be, the obvious suggestion to be registered here is that interesting interactions and productive engagements of this kind arise under conditions that have allowed greater scope for initiative, and attached rewards to actions taken not by Vice Chancellors, but at the levels within these institutions where one is most likely to find the specific information and technical judgments about the subjects of mutual interest to academic researchers and knowledge-seeking corporate personnel. It implies also that when they work successfully, they do so within an ecological that provides a web of supporting connections and mutually reinforcing incentives which need to be studied and understood before attempting to transplant and adapt this important mechanism for "connectivity" in new institutional and cultural settings.[13]

It is only reasonable that considerable effort will be entailed in order to properly align mutual expectations among the parties to a collaboration when they approach the negotiating table with quite different, and conflicting goals that have been organizationally mandated. Nevertheless, the extent to which that investment is undertaken by both sides does appear to strongly shape whether, and how well business-university research collaborations turn out to benefit both parties, and whether they are able to evolve into more enduring "connected" relationships. When one starts the alignment process at the upper echelons of the administrative hierarchies of organizations that are a differentiated in their purposes and concerns as business companies and universities, the conflicts are likely to appear most salient and the prospective negotiation process more difficult and protracted, and uncertain in their outcome; whereas, the existence or absence of common interests and appreciation of the magnitude and division of prospective gains from cooperation usually will be quite readily established. The question then is whether the benefits in terms of the enhanced capacity to carry out the projected line of research are

[13] This caution might be subsumed as part of the general warning against the "mix-and-match" approach to institutional reform and problem selection in science and policy-making, a tendency that is encouraged by international comparative studies that seek to identify "best practices." As has been pointed out by more than one observer of this fashionable practices (but see, e.g., P. A. David and D. Foray, "Accessing and Expanding the Science and Technology Knowledge Base", *STI Review: O.E.C.D. Science, Technology, Industry*, No.16, Fall, 1995) .Examining particular institutions, organizational forms, regulatory structures, or cultural practices in isolation from the ecologies in which they are likely to evolved, and searching for correlations between desired system level outcomes with their presence in the country or regional cross-section data, has been fashionable but as a rule offers little if any guidance about how to move from one functional configuration to another that will be not only viable but more effective.

deemed sufficiently important to their respective (academic and business) organizations that mutual accommodations will be reached to "make it happen."

The organizational structure of most research universities, in which the upper levels of administration typically have at best only a derived interest in pursuing the particular substantive research programs that animate members of their research faculty, and are likely to eschew any attempt to evaluate and prioritize among them on the basis of their comparative scientific interest or societal worth. Accordingly, university administrators rarely if ever approach firms with proposals to engage in particular research projects that would involve collaborations between specified groups or individual faculty scientists and engineers and counterparts who are employed in the business R&D labs. Instead, the research director of a company that has decided that sponsoring a collaborative project with certain university-based research scientists would be beneficial to her organization's "bottom line," usually will have authority to take the initiative of approaching the prospective academic partners to discuss such an arrangement. But, as the latter, in their capacities of research faculty members rather than officers of the university usually do not have corresponding authority to negotiate formal inter-organizational agreements, and the business firm's representatives find themselves told they must deal with the university administration, and more precisely with one or a number of "service units" within the institution (variously described as the office of external relations," "sponsored research office," "university research services," "technology transfer office," all of whom will in one way or another be equipped with legal counsel and contract negotiators.

Reasonable as this may appear as a procedure reflecting the different specializations of the people whose expertise the university calls upon, problems with its operation in practice often arise precisely because the primary concerns of these specialized services typically have little to do with the specifics of the professors' interests in the research collaboration.[14] Rather, their professional purpose is to secure such financial benefits that can be extracted by "the university" (directly or indirectly) in exchange for agreeing that its facilities and faculty resources will be permitted perform their part of the contemplated collaborative work, and that the university will bear responsibility should they refuse to perform in accordance with the terms of the contract. Their competence and role also requires their performance of "due diligence" -- by trying to identify all the conceivable risks and costs that could stem from their institution's exposure to legal liabilities and adverse publicity occasioned by participating in the proposed collaboration.

---

[14] The difficulties occasioned by this internal organizational structure of universities, which contributes to separating the interest of the institution as a "research host" from that of its faculty researchers, thereby placing these research "service units" in a regulatory role vis-à-vis the latter, are considerable. But they are far from arbitrary or capricious, in view of the potential legal complexities that contractual agreements for collaborative research performance may entail. For further discussion see P. A. David and M. Spence, "Towards Institutional Infrastructures for e-Science: The Scope of the Challenges," [A Report to the Joint Information Systems Committee of the Research Councils of Great Britain], *Oxford Internet Institute Report No. 2*. September 2003, [Available at: http://www.oii.ox.ac.uk/resources/publications/OIIRR_E-Science_0903.pdf.]

The uncertainties about the nature of the products and processes of research, conjoined with the professional incentives of those charged with performing "due diligence" – and their inability to calculate the countervailing value of the losses entailed in not doing the research, tend to promote behaviors that reflect extreme risk aversion. In other words, these agents of the university are pre-disposed to advocate and adopt a tough bargaining stance, trying to get the other collaborating party (or parties) to bear the liabilities, or the costs of insuring against them; and when that appears to be infeasible, they are not hesitant to counsel that the project not be undertaken by their institution.[15] What happens in such cases appear to depend upon whether or not the faculty researchers who are keen to do the science are able to persuade people at some higher levels in the university administration that it would not be in the institution's long-term interest to refuse to allow his or her research groups to seize the opportunity of a collaboration with the firm in question. When the individuals in question are valued by their university administration, whether for their academic prestige or for their ability to recruit talented young faculty, or for their track record of success in securing large public research grants and the overhead support that these bring, their persuasive efforts to find a compromise arrangement in which the university does not try to extract the maximum concessions from the firm, or bears more of the risk than its lawyers think is prudent, are likely to be successful. This is especially likely if there is a credible threat that the professor will go to another research institution – where, as the formulaic expression puts it in such conversations, he or she "will feel really wanted."

The point of entering into these seemingly sordid details is to bring into the light the way that complex innovation systems emerge. In the case at hand it will be seen that more active competition among research institutions for productive scientists -- especially where it receives additional impetus from the usefulness of their talents in their university's competition for public research funding, will have the indirect effect of working as a countervailing force against the internal organizational impediments to the formation of spontaneous "connectivity" between academic and business researchers. Regulatory structures that permit universities to compete to attract and retain research faculties that have attained great peer-esteem, and public research funding programs whose allocation criteria give weight to excellence and thereby provide high level administrators justifications for being seen to depart from risk averse institutional guidelines in order to accommodate those individual's pursuit of interesting research opportunities, therefore are affecting positively the formation of university-industry connections that are likely to give rise to future innovations.

---

[15] That this can be an unwelcome surprise to corporate representatives who were under the impression that "the university" would be symmetrically responding to the interest of the faculty counterparts of their own research group, is perhaps responsible for the shocked and disparaging terms in which research directors of large, R&D-intensive U.S. companies relate their experiences in negotiations with universities over the IP rights to joint R&D ventures. See the 2003 survey results reported by H.R. Hertzfeld, A.N. Link, and N.S. Vonortas, "Intellectual Property Protection Mechanisms in Research Partnerships," *Research Policy*, 35 (June-July), 2006 [Special Issue on Property and the Pursuit of Knowledge: IPR Issues Affecting Scientific Research, eds., P. A. David and B. H. Hall], and commentary on this material (as summarized by Table 1) in P.A. David,

The perspective thus gained might be contrasted favorably with the thrust of the enthusiastic notice given by *The Lambert Review* (2003, p. 42) to the recent trend toward opening of "corporate liaison offices" at UK universities:

> Partly in recognition of the number and complexity of these [business-university] relationships, many universities have developed corporate or business liaison offices, with a specific remit to act as the interface with business. These offices have taken on an increasing number of tasks as universities' engagement with their wider community has developed. These include developing networks of businesses; marketing the research strengths of the university; advising on consultancy agreements and contract research; arranging complex collaborative research agreements or major joint ventures.

For the university to present business corporations' representatives with a well-organized corporate academic face, and a central office whose concerns are regulation of external relationships and internal management control of the exploitation of the university's marketable "knowledge assets," may succeed in making European upper-level executives at both institutions feel increasing "at home" in their new contacts. Yet, this organizational measure strikes one as perhaps neither so important, nor so well-designed to respond to the challenge of drawing R&D managers and research personnel into dense and fruitful networks of knowledge-exchange with university-based experts.[16]

Viewed against these findings, the emphasis that was placed by the text of the *Lambert Review* upon the mission ("remit") of the newly established corporate liaison office to be the university "interface with business" is quite striking. To have a liaison officer advising firms of the formal requirements the university is going to impose upon consultancy agreements and contract research, particular those involving complex collaborative research agreements certainly is appropriately instructive and when there is no room for flexibility. Yet putting this function in the hands of a central liaison office encourages pre-commitment of the university to the inflexibility of "standard-form contracts," and thus tends to reduce the scope for exploring a variety of possible legal arrangements the assignment of intellectual property rights, obligations and liabilities that would be responsive to the particular needs of the research collaborators, as well as the concerns of the participating corporate entities. Liaison officers, as the agents of university administrations, are likely to have much stronger career incentives to attend to the priorities of those responsible for monitoring and regulating and monitoring the formalities of the university's external transactions, than to seek ways of fulfilling the actual research *raison d'etre* that provide the impetus for the formation of successful and more sustained inter-organizational connections.[17] To appreciate the tangled lines of

---

[16] It is consequently a bit surprising to find the following statement, attributed to the Lambert Review in EC Staff Working Document [COM(2007), 161/2 :p.52, n.110]: "Indeed, 'the best forms of knowledge transfer involve human interaction', and European society would greatly benefit from the cross-fertilization between university and industry that flows from the promotion of inter-sectoral mobility."

[17] These issues are examined at some detail in P.A. David and M. Spence, "Towards Institutional Infrastructures for e-Science: The Scope of the Challenges," (with M. Spence). A Report to the Joint Information Systems Committee of the Research Councils of Great Britain, *Oxford Internet Institute Report*

influence and indirect effects is to recognize why systems analysis is so necessary in the diagnosis of institutional problems and the design of corrective measures for the innovation process.

4. "Only Connect" – Towards a Vibrant Organisational Ecology of Innovation

To form "a system of innovation" the organisations and the individuals in them have to interact in a way that contributes solutions to innovation problems. Systems depend on connections (interactions) and cannot be described or understood simply in terms of their components. What is at stake here is an idea that goes back to Alfred Marshall's concept of the internal and external organisation of a firm (in *Principles of Economics (8th edition) 1920, and Industry and Trade*, 1919). Flows of knowledge from outside its boundaries are important determinants of its capabilities and actions and any firm but this information is not simply 'in the ether' A firm has to invest in the organisation to gather this information and feed it into and adapt it to its internally generated information.

Innovative activity is perhaps the most important case of the firm's reliance on external sources of information, and leads to the idea that the firm is embedded in a wider matrix of relations that shape its ability to innovate. Hence the concern for the various ways in which universities may contribute to the innovation process that we have outlined above. But it is important to recognise that a firm's internal and external organisation constitutes an operator that is simultaneously facilitating and constraining. The codes and information structuring routines that firms invest in to interact with other external sources of information may also serve to filter and blinker the firm's appreciation of that information which is important and that which isn't (Arrow, 1974). Thus the innovation systems that a firm is part of are not always plastic in the face of changes in the knowledge environment; and, as a consequence, they do fail because their reading of new information is deficient. We should not loose sight of the probability that an innovation system generated to solve one set of problems may prove counterproductive in the context of a new and different set of problems, which is why the processes for flexibly assembling and disassembling specific innovation systems add greatly to the adaptability of any economy[18].

The policy problem may then be put starkly, "Is it possible to improve on the spontaneous self organisation process of the already existing and refined interaction between firms and research universities in Europe?" That the answer may be in the affirmative suggests that the innovation policy response fall into two related branches:

- Policy to improve the chances of innovation systems being formed from the knowledge ecologies of the Member States, a problem that is largely about barriers and incentives to collaborate in the solution of innovation problems.

No. 2. September 2003. [Available at: http://www.oii.ox.ac.uk/resources/publications/OIIRR_E-Science_0903.pdf.]

[18] See J.S. Metcalfe, "Innovation Systems, Innovation policy and Restless Capitalism", in *Perspectives on Innovation*, F. Malerba and S. Brusoni, eds. Cambridge: Cambridge University Press, 2007.

- Policy to improve the quality of the knowledge ecologies in the Member States assessed in terms of the overall supply of researchers in different disciplines and the way in which they are organised to produce knowledge.

The preceding sections have been focused on the role of research universities, and less so on other public research organisations in relation to these two policy problems. But two general points have should be recognised to underlie the whole discussion: it is business firms that occupy the central role in the realisation of innovations, and, it is the mix of market and non market interactions that shape the incentives, the available resources and the opportunities to innovate. Innovation, obviously, is more than a matter of invention and so it is particularly important not to equate innovation policy with policy for science and technology. University-business linkages form only part of this system and their influence on innovation cannot be independent of the many other factors at play.

Thus, for example, the competitive implications of the single market will influence the incentives to innovate whether interpreted as opportunities or threats to a firm's position. Consequently, competition policy is *de facto* an important component of a broad innovation policy just as innovation policy is *de facto* an important component of competition policy. The fact that the knowledge ecology of the EU has been changing rapidly in the past two decades, and that there are important differences in the richness of the ecologies in different Member States, adds further problems in understanding the implications for the innovation process.

The prevailing division of labour in the European knowledge ecology has not arisen by chance, but rather as a reflection of many years of evolution in the comparative advantages of different organisations in producing and using knowledge. Firms, for example, have evolved in ways quite different to Universities because they perform different sets of tasks and fulfill quite different societal functions. This division of labour needs to be respected and understood, for it would be as foolish to make universities behave like firms as it would be economically disastrous to make private firms operate like universities. The differences in their respective modes of operation are not accidental, but have a functional purpose.

The origins of the current ecology, of which the governance of Universities are a part, can be traced back to a historical epoch when the knowledge foundations of industrial processes owed little to systematic scientific understanding and the formal organization and conduct of research and development activities. The modern age is different, however: the great expansion of organized public and private science and engineering research activities that took place during the second half of the twentieth century, and accelerated shift in the structures of the “industrialized” economies toward “services” and away from commodity production, are two important transformations that have in a sense made the university as an institution appear to be, at least outwardly, less distinct from other corporate entities than formerly was the case.[19]

[19] While this does not imply that other institutions and organizations are more interchangeable with the universities in the performance of a number of the latter’s key functions in modern society, it has contributed

The relevant issue then must remain how best to achieve coordination of this division of labour and thereby enhance innovation processes. As we have explored above, the different 'cultures' of business and the public research sector need special attention. The distinguishing feature of fundamental research in science and technology is its open nature, its nature as a science commons[20] Open science (including engineering technology) is a collective endeavour that bases the reliability of the knowledge production processes on widespread agreement as to methods of evaluation and replication but bases radical progress of knowledge on disagreement, the scientific equivalent of creative enterprise. This tension between order and agreement and change and disagreement is at the core of the institutions that shape science.

Similarly in regard to commercial innovation, disagreement is the defining characteristic of any significant innovative enterprise that is necessarily based on a conjecture that imagines that the economic world can be ordered differently. It is the open market system that facilitates adaptations to such disagreement and generates powerful incentives to disagree: the instituted procedures of Science and business are open 'experiment generating systems'; both work within different principles of order and both depend for their progress on the productive channeling of disagreement. The consequences are that the knowledge generating and using processes of businesses and of PROs, operate with different cultures, different value systems, different time frames, and different notions of what their principal activities are. Thus the principal outputs of universities are educated minds and new understandings the natural and artificial worlds, economy, society and so on. The outputs of business are different and involve new understandings of productive and commercial processes for the purpose of producing outputs of goods and services to be sold at a profit. Universities operate with one kind of governance system to achieve their aims, private firms with quite different governance systems and these differences materially influence their interactions in the pursuit of innovation. As has been pointed out, this results in very different norms for the production and sharing of knowledge within and between the two systems.

In both business and the academy positive feedback processes are in operation so that success breeds success. The profits from existing activities that provide the basis for subsequent innovation in a firm have their equivalent in the university in terms of research reputations that serve to attract high quality staff and funding. Indeed the institutions of science are partly designed to create and reinforce this process. The currently articulated attempts by some member states to accelerate this reputation effect through the

---

to the recent tendency of some observers to suggest that universities as deliverers of research and training services might be more effective if they emulated business corporations that perform those tasks.

[20] R. Cook-Deegan, 'The Science Commons in Health Research: Structure, Function and Value', *Journal of Technology Transfer*, vol.32, 2007: pp.133-156; and R. R.Nelson, 'The Market Economy and the Scientific Commons', *Research Policy*, Vol. 33, 2004: pp. 455-471.

competitive allocation of teaching and research funds are bound to further concentrate reputations on a relatively small number of universities.

Because there are strong potential complementarities between the conduct of exploratory, fundamental research in institutions organized on "open science" principle, and closed proprietary R&D activities in the private business sector, it is doubly important to establish market and non-market arrangements that facilitate information flows between the two kinds of organizations. The returns on public investment in research carried on by PROs can be captured through complementary, "valorizing" private R&D investments that are commercially-oriented, rather than by encouraging PRO's to engage in commercial exploitation of their knowledge resources. This is why the strategy that has been expressed in the EU's Barcelona targets is important: by raising the rate of *business* investment in R&D, Europe can more fully utilize the knowledge gained through its public research and training investments, and correspondingly capture the (spill-over) benefits that private producers and consumers derive from the application of advances in scientific and technological knowledge.

Knowledge transfer processes can be made more effective by attention to the arrangements that are in place at the two main points of the public research institutions' connections with their external environments. That a research institute or a university may acquire the attributes of an isolated, inward-looking "ivory tower" is well understood, and their internal processes in many cases tend to encourage this. Universities in the EU frequently are criticized for operating with internal incentive structures that reward academic excellence in teaching and research independently of any potential application to practice in the business or policy realms. This concern is reflected in the newly attributed "Third Stream" or "Triangulation" of the University system, defined as "the explicit integration of an economic development mission with the traditional university activities of scholarship, research and teaching". [21]. Third Stream activities are of many different kinds, and here it is important to distinguish those activities that seek the commercialization of university research (technology licenses, joint ventures, spin offs etc) from activities of a more socio-political nature that include professional advice to policy makers, and contributions to cultural and social life.[22] What is significant about the current debate is the emphasis on the commercialization activities. What is less well understood, and possibly will remain elusive is how to design institutional arrangements that successfully support commercialization while not inhibiting the performance of research and teaching functions that are the primarily social raison d'être for the continued maintenance of the universities as a distinctive organizational and cultural form.

---

[21] T. Minshull and B. Wicksteed, *University Spin-Out Companies: Starting to Fill the Evidence Gap*, Cambridge, SQW Ltd, 2005. Activities of this nature are not linked solely to academic and industry interactions. The tripartite missions in health care to link biomedical research with clinical service delivery and clinical education across hospitals and university medical schools have been widely adopted in the USA and UK. In the later they are known as Academic Clinical Partnerships and they provide the framework within which much NHS funded research is carried out. Segal Quince Wicksteed, 2006, *The Economic and Social Impact of UK Academic Clinical Partnerships*, Cambridge [http://www.cam.sqw.co.uk].

[22] Observatory of the European University (OEU), '*Position Paper*', PRIME Network, 2007.

5. A summing up

Researchers in western universities do make important, fruitful connections with business firms and indeed have done so for many, many years. But, the pressures and changes that Europe's universities now face in markedly different innovation ecologies has raised questions that are focusing attention on the purposes and efficacy of the current extent and modes of university-business interactions. Innovation ecologies only form into innovation systems when the different organisations from the ecology are connected for the purpose of solving innovation problems. Since universities and firms are part of a complex division of labour in which they have each evolved unique characteristics relative to their primary functions, it is not to be wondered that the practices which support these functions do not automatically facilitate interactions among these differentiated organizations.

Public and private policy therefore consequently has an important role to play in respect of the richness and diversity of Europe's innovation ecology, and with respect to the ways in which connections can be formed and reformed to promote a higher rate of innovation. But a fresh look, and "rethink" within an explicit "systems" or organizational ecology framework is in order, because some of the main institutional innovations that have been promoted with a view to enhancing the exploitation of university research are do not seem to be the most beneficial ways of ensuring that university knowledge is translated into greater economic wealth. Indeed, continuing to seek to overcome the barriers to connecting publicly funded research conducted in academic institutions with commercial application, by having those organizations become dependent upon commercialization of research findings and behaving as a proprietary performer of R&D, simply is not sensible. It would jeopardize the open science arrangements that are more effective for the conduct of fundamental, exploratory research – a function that must be fulfilled by some institution if a basis for long-run productivity growth is to be sustained.

Policies that would add to existing pressures on academic communities and their leaders to take on new and different missions, for which their historical evolution and specialized characteristics have not equipped them, run the risk of damaging their ability to fulfill critical functions that no other organizations in the society are prepared to perform will comparable effectiveness. The recognition of a need for new missions in the generation and transmission of knowledge suited to solve problems of innovation in the economy, therefore, would better re-direct attention to more creative solutions. These are likely to involve the development of alternative equally specialized bridging organizations that would gain expertise in the forging of diverse inter-organizational links between the worlds of the academy and the worlds of business.

To explore that option as a promising way forward, however, lies well beyond the scope of the present essay and so must be left to stand as a grand challenge for "mechanism design".