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Technology transfer offices

Technology Transfer Offices (TTOs) encompass different kinds of organisational forms whose common core role is to assist higher education institutes (HEIs) and public research organisations (PROs) to manage their intellectual assets in ways that facilitate their transformation into benefits for society. In doing this, TTOs help to bridge the gap between research and innovation. This policy brief describes the different roles TTOs perform and the organisational forms they typically take; it also outlines the different types of resources required by TTOs and the scope for policy intervention.

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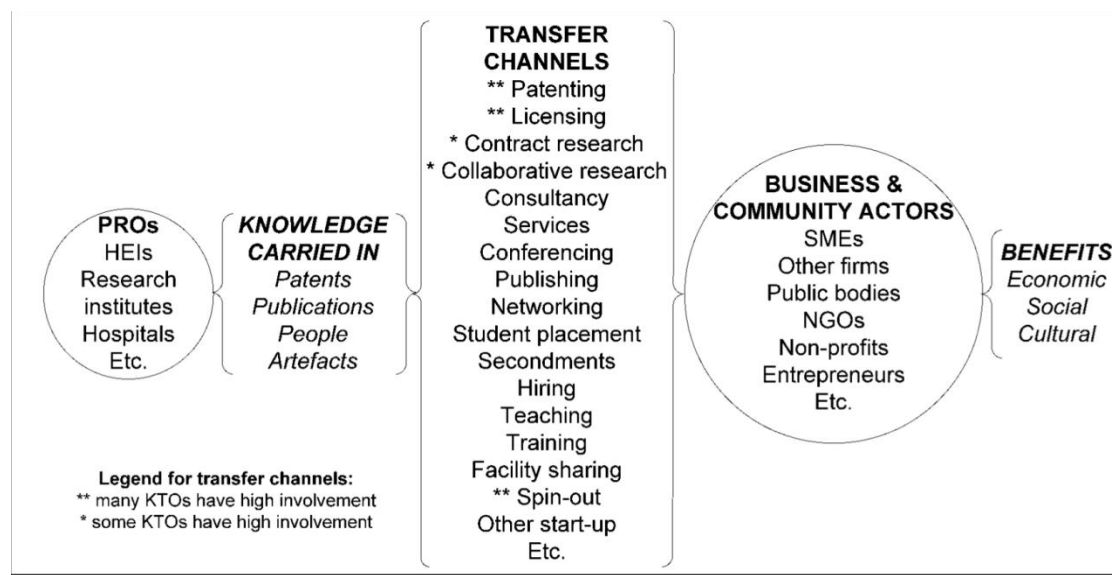
Roles performed

The Technology Transfer Office (TTO) encompasses different kinds of organisational structures whose common core role is to assist public research organisations (PROs) in managing their intellectual assets in ways that facilitate their transformation into benefits for society. In doing this, the TTO helps to bridge the gap between research and innovation. This general role may be declined into more specific ones including:

- establishing relationships with firms and community actors;
- generating new funding support from sponsored research or consulting opportunities;
- providing assistance on all areas related to entrepreneurship and intellectual property (IP);
- facilitating the formation of university-connected companies utilising PRO's technology (start-up) and/or university people (spin-off) to enhance prospects of further development; and
- generating net royalties for the PRO and collaborating partners.

In order to accomplish its assigned roles, the TTO carries out a very variable range of activities relating to different channels of knowledge and technology transfer that involve a contract between the PRO and a third party. These channels may include: collaborative research, contract research, consultancy, spin-off and start up companies, incubator facilities, licensing, and patenting.

Figure 1. Knowledge transfer from PROs and transfer channels in which TTOs (here referred to as KTO) may have high involvement. Source: EC Expert Group on Knowledge Transfer Metrics 2009.



The relative adequacy of each of these channels in the knowledge transfer strategy varies significantly between different industrial and scientific sectors and depends on the nature of knowledge transferred: its disciplinary origin, its breakthrough character, the weight of tacit and explicit elements involved, etc. Likewise, the transferred knowledge is in each case transformed into benefits for society differently.

Likewise, the stage of development and the characteristics of TTOs vary significantly across institutional and national contexts. Particularly, not every TTO handles the full range of TT mechanisms or all of the patenting activities of their affiliated universities. This is especially the case in countries where the inventor owns the right to the IP or when the filing is left to collaborating firms.

In the following points, it will be shown how the roles that different TTOs perform and the manner in which they do so are shaped by evolving motivations and interests, the different resources they can draw upon, the relations they entertain with other actors, as well as the ways in which they are being evaluated. Understanding the evolutions of the actor's attributes can help identifying bottlenecks and opportunities for policy interventions.

Motivations and interests

The kinds of roles performed by the TTO, as well as the mechanisms by which they are carried out are selected according to a series of motivations and interests that are in constant evolution along with policy concerns (1), new theoretical underpinnings (2), and new legal frameworks (3). In this evolution the TTO is moving from a passive to an active role in innovation (4). New challenges are also arising along with specialisation (5).

(1) The innovation paradox: The rise of the TTO is firstly correlated to the evolutions of the linear model of science-based innovation (Etzkowitz & Goktepe 2005). Originating from the Vannevar Bush's 1945 report "Science: The Endless Frontier" and further theorised and applied across OECD countries in the sixties, this policy model provided justification for the government support of research to meet social needs as well as unrestricted basic research with the expectation of eventual useful outcomes. In such understanding, scientific knowledge circulates openly without the need of support from any specialised relational mechanism. However an "innovation paradox" – the underutilization of research results – was acknowledged, producing much policy concern across Europe and in the U.S. This led to the recognition that placing the outputs of publicly funded research in the public domain may not suffice to transform research into social and economic benefits.

(2) A new rationale: Over time, the linear model was revisited along with a progressive co-redefinition of a) the nature of knowledge (as being made of a mix tacit and explicit elements), b) its transfer (the nearer to the frontier, the greater the tacit elements and the more necessary direct collaboration for its transfer), and c) the process of innovation itself (as "iterative" or "whirling" and involving "techno-economic networks" or "distributed processes" (Laredo 2007). In the 70-80's this new understanding underpinned the need to foster university-industry collaborations through linkage mechanisms and policies and legal frameworks to support them.



Against this background, the TTO emerged as a specialised relational operation to nurture the research-innovation nexus.

(3) New legal frameworks: Some TTOs started as early as the 1920's as industry liaison offices. However, their spreading has resulted from the progressive implementation across OECD countries of new legislation that, echoing the landmark US Bayh-Dole Act of 1980, grants PROs title to inventions in order to provide greater legal certainty for firms interested in exploiting research results, lower transaction costs for partners and encourage more formal channels to assist science-based innovation. In keeping with this evolutions, the 2003 OECD study "Turning science into business" focused on TTOs primarily as IP management operations (OECD, 2003). This report presented trends in TTO's IP activity as follows:

As regards patenting, the proportion of patents owned by universities has increased since the mid-1990s in a large number of countries (notably in Japan and some European countries). However, most European PROs present a lower number of patents than their US counterparts. Over 2003-05, 4% of all international patent applications were filed by universities. The approach to patenting has been geographically broad, mainly at national level, but also abroad or at European-wide level. In general, patenting outcomes has been closely linked to the booming field of biotechnology (particularly in Belgium, The Netherlands, Germany and Switzerland) or, more generally, to the country's domain of technical specialisation. In other countries PROs' patenting has been taking place mainly in IT and electronics (e.g. Korea), as well as in health, food and energy.

As regards licensing, only a few TTOs negotiate more than 15 licences each year. Comparatively, US firms tend to demand more licenses from PROs than the European counterparts. Licensing of IP has proved to generate extremely variable amounts of revenue among OECD countries ranging from the thousands to the low millions. The license revenues of an average US university technology transfer office are typically 10 times larger than that of the European counterpart. The number of licences yielding revenues is also larger in the US than in Europe. In many countries (Switzerland, The Netherlands, Belgium, and Japan) PROs have mainly licensed to large foreign companies. However, a few PROs are increasingly licensing IP to spin-off or start-up companies.

(4) A more active approach: These trends in TT are telling of an evolution from an "open science" model (in which the PROs did not retain any IPR) to a "licensing model" (in which the PROs are entitled to retain, protect and commercialise inventions). However, as new transfer mechanisms develop, the TTO is currently further shifting from passive commercial exploitation, i.e. collecting license fees and royalties from industry to a strategic management of IP by engaging more actively in translational research to explore the potential of discoveries and in business development to assist the creation of new IPR-based companies (spin-offs and/or start-ups). Comparatively, this has been called the "innovation" model. This trend is comparatively larger in certain European countries (the UK, the Netherlands, Belgium and Germany) than in the US.



(5) New challenges: With the progressive professionalization of transfer activities new questions arise: Does IP management actually produce significant revenues? Does it introduce barriers to the flow of research outcomes? Does it affect the quality of research? Does it lead to conflict of interest? How should the benefits be shared? Such issues bring to the fore the specific question of what drives the TTOs to select the channels and roles. To this respect, it has been noted that without a suitable strategy in place, specialisation and a resulting inward focus on the TTO, may induce towards maximising its own benefits, rather than those for society (EC Expert Group 2009: 9). Indeed, TTOs activities can be schematically characterised along a scale according to whether the objectives lie in knowledge sharing for long-term innovation or short-term financial return for the TTO (Cullen 2007). These have proved to be conflictive motivations and interests of TTOs. Whether PROs will tend to move towards one objective or another will depend on the success – or failure – to implement policies, institutional frames and management leadership that ensure effective innovation in the long term.

Resources

TTOs draw upon different kinds of resources: organisational (1), financial (2), human (3) and network resources (4). The arrangements that set the optimal way to ensure, manage and allocate these resources are shaped by the PROs' policy as regards innovation in general and TTOs' mission in particular.

(1) Organisational models: Across OECD countries, several different organisational structures have been established to carry out TT activities. In some countries, like Germany or the US, TTOs have existed for many decades. In most cases, however, TTOs are relatively small, recent structures, mainly established after 1990. Currently, many PROs are involved in a continuous process of experimentation and learning about the relative pros and cons of various types of organisational arrangements.

On the one hand, most TTOs function as on-site administrative department integrated into the PRO it serves. In many cases, however, the department is not exclusively devoted to technology transfer activities. Such in-house TTOs may sometimes be ill equipped in terms of financial and human resources. Thus, it may be unable to provide the most complex activities linked to IPR, which are outsourced. However, well-established in-house TTOs may benefit of a close working relationship with researchers who may provide a key resource to perform the transfer process.

On the other hand, TTOs are increasingly developing an arm's length relationship to the PRO. Such TTOs provide a dedicated service for one or various organisations, especially where individual PROs do not have the scale necessary for having a local TTO of their own. There has been as well some recent experimentation with regional or sector-based TTOs. This centralised approach to TT may allow realising economies of scale by spreading fixed costs over a large number of inventions and exploiting the benefits of portfolio diversification. A potential drawback of these models is, however, physical distance from researchers PROs.

Finally, TTOs can be external (private or public) organisations, which have been established as for-profit service entities that provide a financially motivated service. Such a service may be appropriate for organisations with only occasional inventions, but may not be the most appropriate choice to attain effective technology transfer.

The trends in the development of these models depend on the existence of legal incentives to develop such structures as well as on the kind of PRO: universities with research groups in different fields, fundamental research organisations, government labs, and contract research organisations play diverse roles in innovation systems, generate diverse types of knowledge and require different TT management processes. Accordingly, the appropriateness of one institutional arrangement or another depends on the context in which the PRO operates: its status as a private or public institution, the amount of public funding it receives, its funding capacity, the size of its research portfolio, its geographical proximity to firms and its insertion in innovation networks.

(2) Funding: There are also different schemes of TTO financing. As with the organisational models, its diversity reflects the same basic dilemmas about what the functions of a PRO in support of innovation should be and raise difficult questions about where responsibility for funding TTO activities should lie. Most TTOs receive public funding by the allocation of a budget from the PRO it serves. However, in spite of the increasing recognition of a “third mission” or “third stream activities”, only few PROs do receive suitable additional public sector funding to support technology transfer. In a context marked by financial pressures on the teaching and research functions, PROs face serious difficulties to bear alone the burden of the long-term financial investment required for the innovation process.

Generally, TTOs can also draw upon a mix of funds resulting from their activities, namely a share of the capital gains on spinout equity participation, a portion of the net royalty on licensed technology, or an overhead on collaborative research agreements. The expansion of TT services may allow them broadening the revenue base so as to ensure financial sustainability. However, this raises again the dilemma about striking a balance between different channels: whereas the overhead on collaborative research may have the positive effect of encouraging collaboration with third parties, dependence on license revenue may conversely impact negatively in the innovation process, leading the TTO to give preference to the discoveries or inventions most easily commercialised which are not necessarily those generating most benefits for society.

Since TT is not actually delivering products but technology opportunities, income generation is not systematic and, therefore, it cannot provide a suitable basis for financing effective TT. Indeed, only few TTOs operating in booming technological fields have managed to generate sufficient income to exceed expenditures and make IP transfer a major financial success. It takes at least 10 years to develop enough royalty revenues to make IP management financially sustainable (Mowery et al. 2001). Given that TTOs are more often than not recent structures, financial and legal support is necessary if successful TT is to be attained.

(3) Personnel and internal rules: For the most, TTO often consist of no more than 5 staff in full time equivalent) coming from different backgrounds. However, many TTO are still ill equipped and professionalization remains a major challenge. Indeed, most PRO's cannot offer competitive salaries attracting highly skilled specialists for the TTO able of understanding legal frameworks of IP, managing new business, and dealing with technological opportunities. To tackle this issue, some PROs are adapting human resources policies to give greater recognition of TT activity in recruitment and career advancement, as well as to ensure good relationship with the researchers. As regards this last point, policies, rules and procedures for all the relevant functions performed by the TTO are also critical. If conflicts of interest are to be avoided, these need to be widely accepted. A strong leadership from PRO management is accordingly critical.

(4) Networks: Finally, insertion into TTOs networks linking other TTOs and technology managers from industry is an important source of resources for individual TTOs. Networks can be informal or formal; some have become highly successful, professional support organisations, like in the US the Association of University Technology Managers (AUTM) or in Europe the various TTO associations operating both at the national level and the Association of European Science and Technology Transfer Professionals (ASTP) at the European level. These networks provide an important support with the organisation of training seminars, and meetings for exchanging views and disseminating best practices, which are critical to harmonisation and benchmarking.

Interactions

The TTO maintains strategic relationships to function as an interface between different actors and the PRO. These include: the PRO community (1), industry and other community actors (2), and government (3).

(1) The PRO community: To the “inside”, the TTO functions in close relation with the PRO community (both its administrative and academic management and its faculty including professors, researchers and students) that it serves. The TTO is, overall, the PROs key operation that facilitates new relationships with third parties from which result many benefits (sponsored research, consulting opportunities for faculty and graduate students, royalty income, etc). In doing so, the TTO may also work to prevent potential conflicts of interest. The TTO also assists researchers in the management of their research contracts. It may also be their primary source of service and assistance on IP-related issues. This service goes beyond applying for patents: TTOs are indeed frequently involved in receiving invention disclosures from researchers as well as in deciding about the innovations that may be ripe for protection and about which means are the best suited. TTOs also take part in the negotiation of contracts that specify how IP should be used or revealed (non-disclosure or confidentiality agreements). Some TTOs are as well involved in other non-patent IP actions, like copyright registration for creative works and less commonly in industrial design registration, and plant breeders' rights applications. In some countries, other actions taken by TTOs may include registration of trademarks, brand names, and domain names, and the negotiation of material transfer



agreements. When IP management is outsourced, the TTO enters into relation with specialised legal and patent service providers. If on the one hand it serves researchers, the TTO also relies on their active involvement and support to achieve successful TT. Indeed, researchers and their informal networks often remain critical resources for many tasks such as stimulating invention disclosures or finding licensees. This testifies to the importance of involving scientists in the process.

(2) Industry, business and community actors: To the “outside” of the PRO, the TTO enters into relation with different industry, business and community actors (large multinationals, SMEs, entrepreneurs, NGOs, non-profits, “concerned groups”, etc) to identify opportunities to build different links which allow knowledge co-production (research agreements, consulting) and circulation of PROs codified knowledge assets (patents, licenses) between the PRO and them. In managing these linkages, the TTO interacts with various industry personnel (research & development, business units, executive management, patent counsel, law department, etc). Most PROs often choose to establish agreements with, and licence to large existing companies, which are seldom local. However, some TTOs are increasingly interacting with finance (business angels, venture capitalists, banks) and different entrepreneurs to engage in the formation start-ups and/or spin-offs. In developing technology transfer through entrepreneurship, the TTO may play a passive role (limited to providing referrals to resources that can assist in the start-up process) or an active one (getting involved in the development of the business plan, the setting up of the company, finding initial seed funding, recruiting the management team, and securing the first round venture funding). Forming a new company is often the best alternative to move a technology forward, namely due to the reluctance of existing firms to develop early-stage technology, as well as to the seldom sufficient translational research capacities in academia. Inventions that may lead to a wide range of application (platform inventions) are more likely to be licensed to spin offs than to existing firms. Also, licensing to such companies may allow PROs to retain greater control and access to the IP. Small firms and spin-off and start-up companies often demand exclusive licenses to offset the concomitant risks. This may raise concerns about possible drawbacks in the diffusion of publicly funded research. However, the TTO may often include clauses of limited exclusivity in contracts, thus protecting public interests. The choice between exclusive licensing, non-exclusive licensing, and free licensing depends, however, on the PRO’s strategy for its TTO. Finally, TTOs may also engage with technology incubators to support spinouts and research-based firms in various fields, often located next to the originating PRO, sometimes in a science (or technology) park, to which they are a natural transition, contributing more directly to the local economy and to the support of the research function of the PRO.

(3) Government and public bodies: the TTO is also in relation with governments (local, regional, national and supranational), public bodies and all kind of public research funding. The TTO may also build different formal links with government to develop research agreements, consulting work and expertise, involvement in regulatory committees, participation in policy and programme development, etc, particularly at a local and urban levels (e.g. in urban planning, environmental management, etc.) This reflects a sort of public service dimension of research activities that also involves non-market relations.



In all these interactions, it should be noted, knowledge flows in both ways for the relation itself often provides a basis for producing new knowledge.

Evaluation

Technology transfer activities need to be evaluated as any other function of PROs. However, there are still few common formal review procedures established for TTOs. In the US, reviews about the success of the Bay-Dole legislation led the AUTM to the implementation of surveys to review the financial benefits of TTOs activities and identify whether the desired outcomes were achieved. Since then, counting the number of manifestations in the different transfer channels managed by TTOs has become the most frequent way to measure technology transfer activities that the PROs are involved in. Few OECD countries, however, regularly collect the necessary data; when they do so, they often use different indicators, definitions, and coverage thus making full comparability across countries difficult.

The EU Expert Group on Knowledge Transfer Metrics identified indicators used in several existing recurrent surveys of TTOs (the Group refers to TTO as included in the slightly larger category of Knowledge Transfer Offices or KTOs), nominated seven of these as core indicators and proposed common definitions. Most surveys of TTO knowledge transfer activities follow the AUTM in collecting data for six core indicators: three for the potential commercialisation of public science: invention disclosures, patent applications, and patent grants; and three for the use of public science by firms: number of licenses executed, established gross license revenue, and number of spin-offs/start-ups. Many surveys also collect data on research agreements. These seven core indicators can be supplemented by other non-core indicators for a more detailed monitoring: knowledge transfer involving SMEs, knowledge transfer involving domestic firms, knowledge transfer involving the research organisation's own region; exclusive licenses, share of valid patent portfolio that has ever been licensed, patent share of license income, and technology areas for patenting. Finally, many surveys also collect a wide spectrum of data concerning the TTO and the PRO: type(s) and number of affiliated PROs, TTO size, total TTO costs, outsourcing of IP services, reference year for data collected, research expenditure in the reference year, and research personnel in the reference year.

Beyond monitoring policy impact, surveys of TTOs are also used to support benchmarking and exchange of best practices. Using these surveys for comparable indicators requires however agreement over definitions methodologies, coverage, and presentation of results. In order to improve comparability, performance indicators should be published as normalised by research expenditure or research personnel.

Sensitivity to policy intervention

(1) Legal frameworks: Governments shape the legal framework for IP management at PROs that determine the institutional infrastructure that supports technology transfer from public research. Revision of different laws and regulations is a critical move to spur TTOs. This includes a) reforming IP laws to grant PROs title of their staff inventions (as Austria, Denmark, France, Germany and Norway have recently done), b) modifying funding regulation to give

PROs control of the IP generated by researchers (as in Germany, Canada, the U.K, and more recently Japan and Korea), and c) reforming fiscal and/or employment regulations that prevents PROs from receiving and retaining royalty income from licenses (as in the U.K., Germany and Korea). However, these measures do not necessarily suffice to ensure effective TT. Accordingly, further policy intervention is necessary to enhance TT management capacities at PROs.

(2) Coherence and consensus: Along with the revision of legal frameworks, PROs' management needs to be encouraged to engage with TT, acknowledging it is a primary part of research management. Having heads of TT operations report directly to directors in PROs may be a way to foster this. PRO senior management leadership is essential to have a common accepted TT mission with policies widely disseminated at all the institutional levels. A change in the culture and mindset of researchers is however a major challenge. As Ireland and Canada have done, developing codes of practice or general guidelines for PROs on different aspects of TT activity may be necessary to foster greater coherence. Additionally, as a matter of equity and as an incentive to motivate researchers, specific regulations may be needed to impose PROs to share the benefits from licensing inventions with the inventors.

(3) Resources: PROs also need to have the means to professionalize TT. This implies ensuring the necessary human (a), financial (b) and organisational resources (c).

- a) PROs need to be able to attract managers that have the suitable mix of skills and experience with competitive salaries and career prospects. Modifying public pay regulation may be accordingly needed to facilitate recruitment of qualified technology transfer personnel as well as to offer career prospects. Developing TT training programmes for engineers, scientist, and lawyers either through direct schemes or via national patent may also be important to create a pool of specialists.
- b) Since few TTOs are able to generate net revenues, PROs need to receive specific government subsidies for their TT structures in their early stages (like in Denmark, Germany and Japan). Certain public sector organisations have begun to provide funds for supporting TT function of PROs, though programmes and initiatives like the UK "Knowledge Transfer Grant" or like the US legislation requiring that national laboratories grant 0.5% of their budgets for TT functions. Governments can also indirectly support PROs IP activities by lowering or subsidising the costs of patent protection, or by having research councils and funding agencies allow grant recipients to use research grants for pay IP-related costs. This, however, may dilute the quality filter implied by higher costs. The challenge, nonetheless, also lies in encouraging other stakeholders to support TT investment costs. In this sense, some TTOs have gained support from both industry and venture capital firms that facilitate the access to funding and expertise for furthering early-stage developments. Accordingly, government programmes that incentivise all other relevant stakeholders to engage in supporting TT activities at PROs are necessary to ensure that their mission is oriented towards effective TT rather than mere short-term revenue generation strategy.



- c) Finally, governments can also sponsor the set up of joint organisational structures (e.g. regional or sector based) or networks of operations that serve several small PROs lacking of financial or managerial resources or critical mass to have a TTO of their own, as in Denmark, Germany, Korea and the U.K.

(4) Monitoring and indicators: Policy intervention is needed to encourage regular surveys of TTO activities to provide input to policy makers on impact and to help PROs benchmark performance and learn from one another. Requirements and guidelines by government funding agencies about reporting on TTO activities can be a good strategy.

The U.K, the U.S., Canada, and Australia have been pioneers in measuring the potential returns from TTO activity. Such approach is however strongly influenced policy focus on patenting and licensing as the main TT activities. Other TT channels beyond these need, however, to be measured systematically in order to accurately assess performance in all the objectives of the TTO. Likewise, since TTOs are only one of the stakeholders in the science-based innovation process, additional indicators still need to be developed for enhanced monitoring of TT. For example, it has been recommended that available indicators such as the percentage of firms that give a high importance to knowledge obtained from PROs be considered along with indicators of formal knowledge transfer activities in policy development.

Actors collecting data on TT from PROs need furthermore to agree on using common indicators, definitions, methodology, etc. More importantly, since performance targets and measurements are only possible once there is agreement about the mission, the targets and the way to achieve these, all TT stakeholders and networks need to be encouraged to collaborate and routinely discuss experiences with the implementation of the monitoring systems as well as to prospectively take initiatives to enhance and expand the range of shared indicators on agreed objectives. This is necessary to strike a balance between promoting knowledge transfer methods based on IPR and licensing and those of open science. Indeed, as the EU expert group has warned, incentives for TT should reflect public policy and not the available indicators. An indicator always sends a signal to interested parties to try to improve performance on this aspect being measured. Only providing indicators for the commercialisation of science could act as an incentive to perform in those channels at the expense of others. Accordingly, metrics should be used with caution.



Further resources

AURIL Handbook of Intellectual Property Management,
<http://www.patent.gov.uk/about/notices/ipguide.pdf>

AURIL/UUK/Patent Office (2002), Managing Intellectual Property – A Guide to Strategic Decision-Making in Universities, <http://www.patent.gov.uk/about/notices/manip/index.htm>

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OECD work on patent statistics: www.oecd.org/sti/ipr-statistics

PROTON: <http://www.protoneurope.org/>

