

Interface with universities and public research institutes

Co-operation and the flow of knowledge between universities and public research institutes (PRIs) can significantly support innovative businesses: research organizations can be co-partners for innovative firms and also a source of innovative entrepreneurship with the creation of research spinoffs. Moreover, access to research and knowledge produced by these institutions can be an essential input for innovative companies. Evidence confirms the positive effects of the university-industry interface for the success of innovative firms. The evidence shows that university-industry linkages are of increasing importance but differ substantially across countries. The success of innovative firms' interactions with universities and PRIs depends on the effectiveness of the IP system, the development of markets for technology and the existence of a suitable business support infrastructure. The interface with universities and public research institutes, in turn, affects innovative firms' access to labour and investment in R&D and innovation. Public policy can help foster university-industry relations by providing an adequate framework (including a suitable incentive structure) for universities to commercialise their knowledge creations, as well as supporting ways to disseminate knowledge created by universities, notably by supporting open access policies. Improving the capacity of businesses to engage with universities is also important.

What is the interface with universities and public research institutes?

This theme deals with the co-operation and flow of knowledge between universities, public research institutes (PRIs) and the private sector.

Interactions between universities and industry, in addition to the important role of supplying skills, can take place through a variety of channels, such as:

- joint research projects
- university consulting arrangements provided for industry
- people-based interactions between creators and users of new knowledge
- knowledge creation for industry via the publication of research results and possibly also through obtaining intellectual property rights (e.g. patenting)
- entrepreneurial activities of faculty and students (e.g. spin-offs)
- the mobility of highly skilled students and faculty from universities to industry and vice versa.

The university-industry interface differs, depending on the type of knowledge relevant to different industries. A relevant distinction is the one between “analytical” and “synthetic” knowledge bases (Asheim and Gertler, 2005; OECD, 2010).

- **A synthetic knowledge base** dominates industrial settings where innovation takes place mainly through the application of novel combinations of existing knowledge. Innovation is driven by the need to solve specific problems arising in the interaction with clients and suppliers (e.g. advanced manufacturing). In such sectors, research is less important than development. University-industry linkages play an important role, but they tend to take the form of applied problem solving rather than basic research. Relevant university-industry knowledge transfer mechanisms will involve faculty consulting, student placements, or cooperative education programmes.

- In contrast, **an analytical knowledge base** refers to industrial settings where the production process draws on sources of scientific knowledge that make extensive use of cognitive and rational models. Prime examples of industrial sectors that rest on this type of knowledge base are information technology and biotechnology. Firms in these sectors tend to draw upon research results from the higher education system or national laboratories as a source for potential innovations or product modifications. Knowledge transfer mechanisms, such as patents, technology licensing and collaborative research, are key to enterprises in this area.

How does the interface with universities and public research institutes affect innovative entrepreneurship?

University-industry interface can contribute to the development and commercialization of innovations in the following ways:

- **Co-creation of knowledge** involving universities and firms. The benefits of joint research projects may include access to highly skilled human resources, complementary R&D capabilities and different approaches for problem solving (Bishop et al., 2011).
- **Access to university research and discoveries** (Lee, 2000; Cohen et al., 2002; Zucker et al., 2002), and the exploitation of their commercial potential by companies (e.g. through licensing).
- **Creation of research spin-offs by faculty members.** Research-based spin-offs are generally understood to be small, new technology-based firms whose intellectual capital originated in universities or other public research institutes. The dimensions that differentiate spin-off firms from others are the type of resources they draw upon, their prevailing business model and their links to research organisations. Such spin-offs are created in order to commercially deploy new knowledge generated by public research organisations.
- **Knowledge diffusion** (e.g. due to networking between faculty members and firms' employees), which may increase firms' ability to find and absorb technological information, and provide them with information about trends in R&D.

Exploiting university-industry linkages will be important for innovative businesses, since this can help them to compensate for possibly limited internal resources and infrastructure for conducting R&D and other costly innovation activities. Collaboration on innovative activities can also subsequently encourage business investments in R&D, thus generating a positive cycle between innovation through external linkages and innovation through internal investments in R&D (OECD, 2009).

Evidence on the importance of the interface with universities and public research institutes for the success of innovative businesses

- Evidence shows that interactions with universities and PRIs can bring a wide range of benefits to firms, such as increases in product development, innovation and productivity (Lee, 2000; Cohen et al., 2002; Adams et al., 2003; Hanel and St-Pierre, 2006; Arvanitis et al., 2008; Dutrénit et al., 2010a; De Fuentes and Dutrénit, 2012). These benefits have arisen from joint and contract research, and use of consultancy services, among other types of interactions (Arza and Vazquez, 2010; Dutrénit et al., 2010; De Fuentes and Dutrénit, 2012).
- Interactions between universities and businesses depends on multiple firm characteristics,

such as the firm's age (Eom and Lee, 2009; Giuliani and Arza, 2009), the firm's size (Cohen et al., 2002; Hanel and St-Pierre, 2006), the sector, the type of R&D activities performed by the firm and the geographical proximity of the firm to high-quality public research organizations. For instance, large firms in most countries are usually twice to three times more likely to engage in industry-science relationships than small and medium-sized enterprises, as shown in Figure 1 (OECD, 2012). Similarly, some sectors, such as natural resource industries, have lower R&D intensity than average, so firms in these sectors will be less prone to collaborating with universities and research organisations.

Evidence on the importance of the interface with universities and public research institutes for the performance of innovative entrepreneurs

There is also evidence to suggest that SMEs with external innovation linkages tend to perform better in terms of innovation and growth compared to those without these linkages (Powell and Grodal, 2005; Stuart, 2000; Baum, Calabrese and Silverman, 2000; Davenport, 2005). This finding, however, may also be partly related to the fact that better-performing SMEs will select into such types of cooperation.

Figure 1. Firms collaborating on innovation with higher education and PRIs

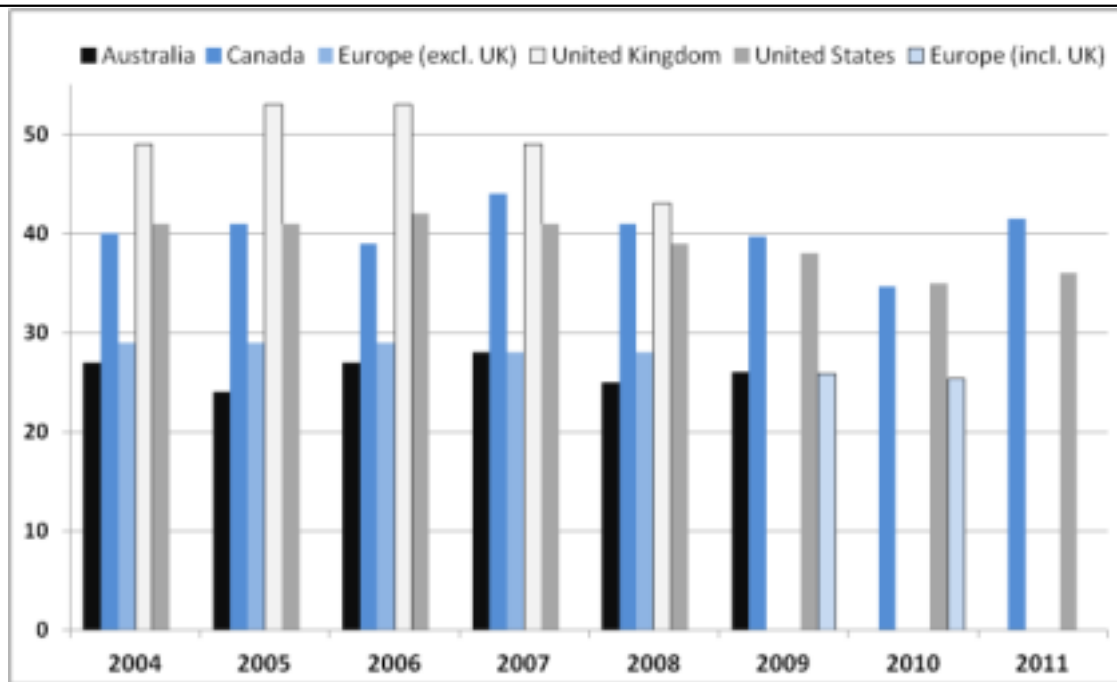
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What is the evidence on the interface between universities and public research institutes and innovative businesses?

Evidence of the interface between universities and industry

- **Invention disclosures and patent applications from universities.** Invention disclosures registered by technology transfer offices (TTOs) and patent applications from universities may reflect a researcher's willingness to engage in commercialisation activities. Data from selected OECD countries indicate that invention disclosures per USD 100 million per annum have stagnated over 2004-2009 (Figure 2). Scientific institutions in the UK (for 2004-2008) and in Canada (for 2007-2009 and 2011) perform slightly better in terms of invention disclosures than US institutions and significantly better than Australian and European institutions.

Figure 2. Invention disclosures, 2004-2011
Per USD 100m research expenditure



Notes: 1. Not all questions asked in the surveys in each country are directly comparable. Some surveys include PRIs, universities and hospitals whereas some only universities. There are also differences in definitions of output and of R&D expenditures as well as in treatment of missing values (see Arundel & Bordoy 2008 for discussion).

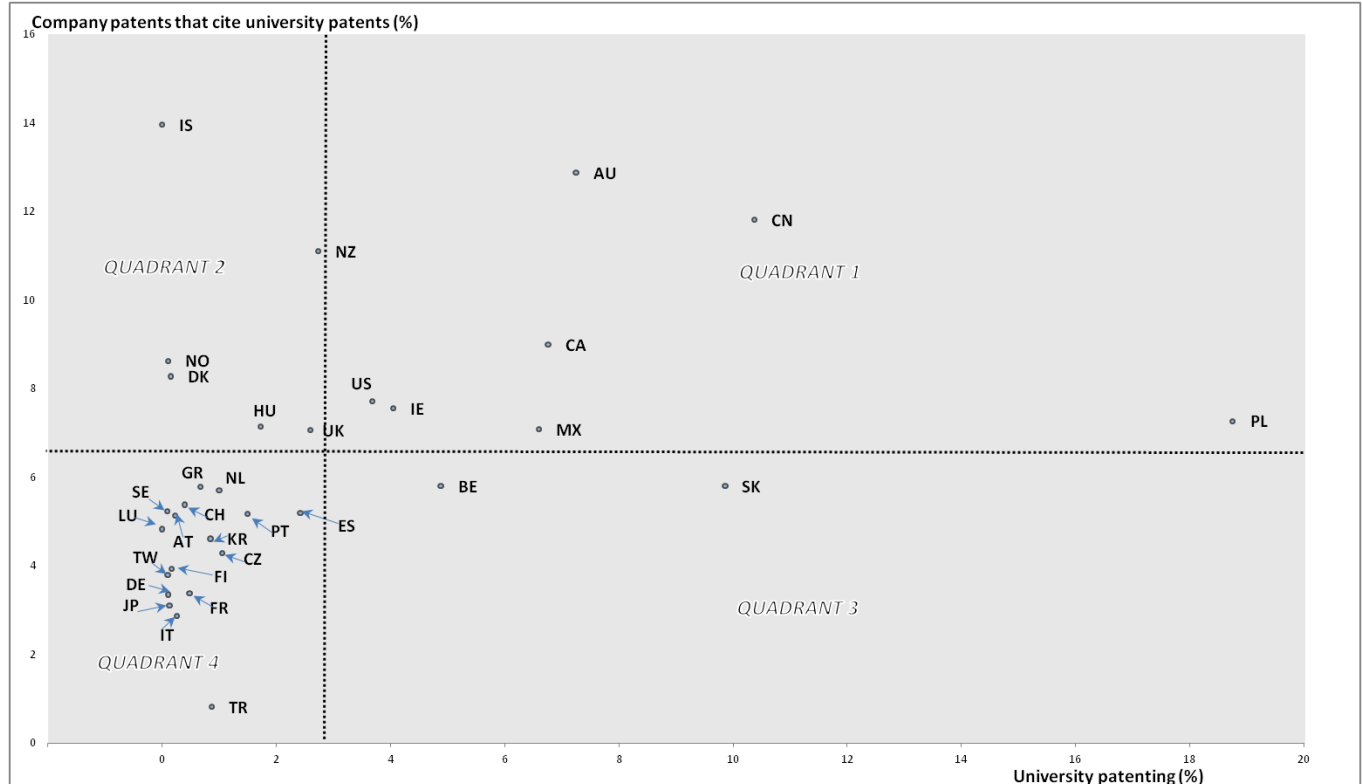
2. Survey data (Fiscal Years): US: US Association of University Technology Managers (AUTM) (2004-2011); Canada: Canadian Association of University Technology Managers (AUTM) (2004-2011); Australia: National Surveys of Research Commercialisation (NSRC) (2004-2009); Europe (excl. UK): Association of European Science and Technology Professionals (ASTP) (2004-2009); UK: Higher Education Business and Community Interaction Surveys (HE-BCIS) (2000-2008). Europe (incl. UK): Proton Seventh Annual Survey Report (2009) and European Commission (2010).

3. Comparisons after adjusting for research expenditure (per \$US100m) and US dollar purchasing power parity

Source: OECD based on data and calculations from European Commission (2012), Australia's Department of Innovation, Industry, Science and Research (2011), US Association of University Technology Managers (AUTM) (2008)-(2012), Canadian AUTM (2008)-(2012)

- Citations of university patents in business patents.** National differences in business patents citing university technology may indicate both the extent to which national innovation systems incorporate academic knowledge and the extent to which national systems are able to further develop academic knowledge (Veugelers et al., 2012). Figure 3 shows that company patents citing university patents account for a relatively high share in countries such as Australia (13%), China (12%), Canada (9%), the United States (8%) and United Kingdom (7%). This is less the case in Korea (5%), France (3%), Japan (3%), Germany (3%) and Italy (3%). Australia, Canada, China and the United States combine high levels of university patenting with high levels of business patents citing university patents (Quadrant 1), whereas Japan, Germany, France, Sweden and Korea have both a low supply of and a low demand for university patents (Quadrant 4).

Figure 3. Share of university patent applications and share of business patents citing university patents (%)
Patent applications: EPO application years 1980-2000; Corporate patent citations: EPO application years 1990-2009



Note: *Quadrant 1:* high number of university patent applications (%) and high industry demand of university patents (%); *Quadrant 2:* low but high industry demand of university patents; *Quadrant 3:* high supply but low industry demand of university patents; *Quadrant 4:* low supply and low industry demand of university patents

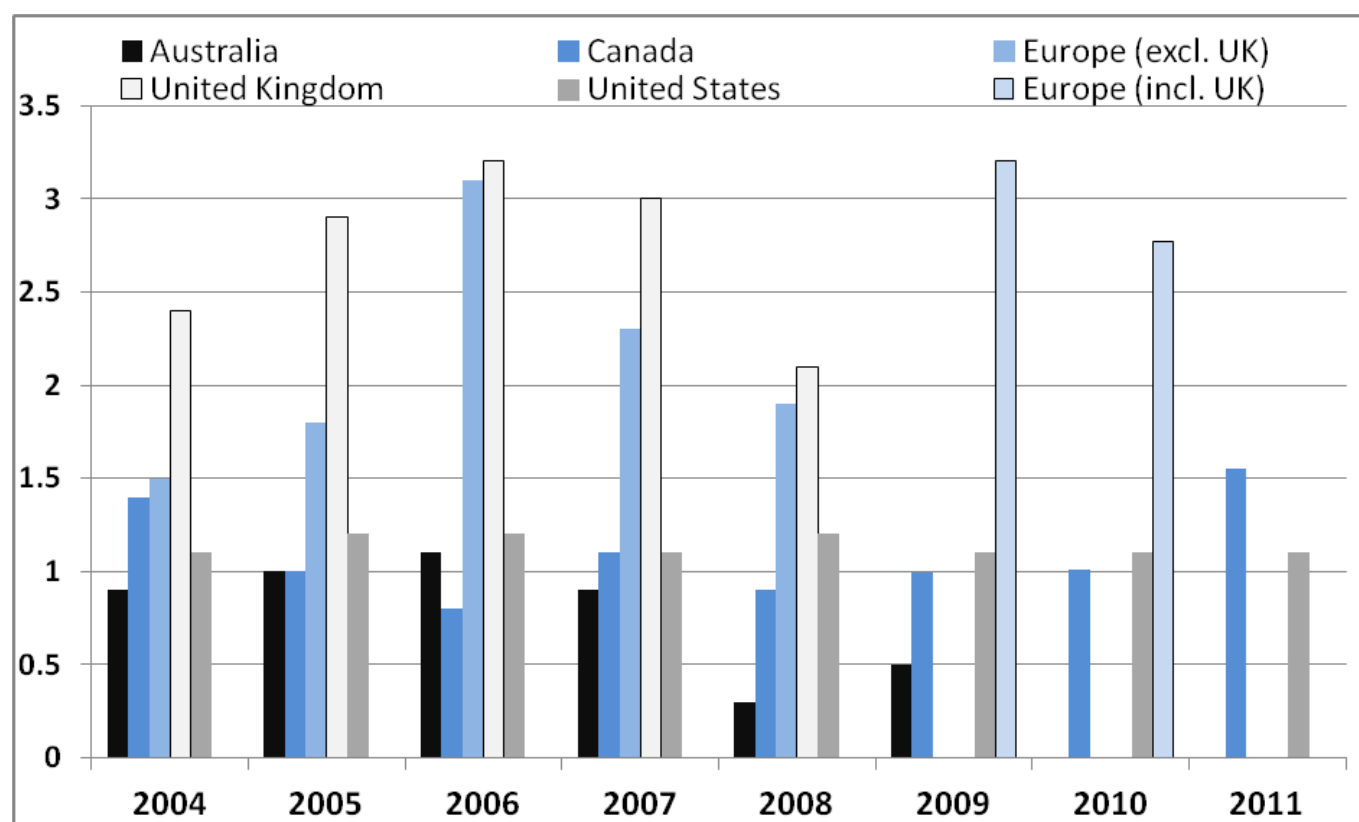
Source: Veugelers, R. et al. (2012), "The participation of universities in technology development: do creation and use coincide? An empirical investigation on the level of national innovation systems, *Economics of Innovation and New Technology*, Vol. 21, pp. 445-472

- **Licenses granted by universities to businesses.** Evidence shows that the average number of licences granted by universities is much lower in the United States than in Europe (OECD, 2010). There are two possible reasons for this. One objective issue is that the US patent system is significantly less expensive than the European system. Another argument is that European universities are more reluctant to apply for patents for which they do not perceive a concrete licensing opportunity. However, the value of licensing revenues associated with Knowledge-Transfer Offices (KTOs) in the United States is markedly higher than in Europe. The average value for a US KTO is over EUR 10 million, whereas it is only EUR 212,000 for a European KTO.

However, these measures only provide a partial picture of university-industry interactions. Other knowledge flows that are more difficult to measure (e.g. informal contacts, conferences, consulting, publications and the movement of students) play an important role in the transfer of knowledge from universities to businesses. Some studies and surveys have attempted to capture these less codified channels. For example, the Carnegie Mellon Survey of Industrial R&D found that the most commonly reported mechanisms for diffusion of public research to industry were publications, conferences and informal exchanges. Patents ranked low in most industries, except for pharmaceuticals (Cohen et al., 2002). The Cambridge Centre for Business Research Survey of Knowledge Exchange Activity by United Kingdom Businesses also shows that the most frequent forms of academic interactions with external organisations are related to people-based activities, such as participating in networks or attending conferences (Hughes et al., 2010).

Spin-off creation. While spin-off creation has received substantial attention in the literature, it remains one of the more rare forms of knowledge transfer activity involving start-ups (Wright et al., 2012). There are, however, strong variations across OECD countries in the number of spin-off companies formed per USD 100 million in research expenditures. On average, the UK (2.72 spin-offs per USD 100 million for 2004-2008) and Europe including the UK (3 for 2009-2010) have maintained a higher rate of spin-off formation than the United States (1.1 for 2004-2011), Canada (1.1 for 2004-2011) and Australia (0.8 for 2004-2009) over most measurable years (Figure 4). There are, however, substantial differences regarding the worth of different spin-offs. Yet evidence shows that only a small proportion of institutions are responsible for a large proportion of spin-offs: Callan (2001) reports that academic spinoffs accounted for no more than 2% of new firm creation across eight OECD countries. Nonetheless, they represent a higher proportion of new technology-based start-ups. Almost one-sixth of all new technology-based firms in Sweden are spin-offs from universities.

Figure 4. Creation of public research spin-offs, 2004-2011
Per USD PPP 100m research expenditure



Notes: 1. Not all questions asked in the surveys in each country are directly comparable. Some surveys include PRIs, universities and hospitals whereas some only universities. There are also differences in definitions of output and of R&D expenditures as well as in treatment of missing values (see Arundel & Bordoy 2008 for discussion).

2. Survey data (Fiscal Years): US: US Association of University Technology Managers (AUTM) (2004-2011); Canada: Canadian Association of University Technology Managers (AUTM) (2004-2011); Australia: National Surveys of Research Commercialisation (NSRC) (2004-2009); Europe (excl. UK): Association of European Science and Technology Professionals (ASTP) (2004-2009); UK: Higher Education Business and Community Interaction Surveys (HE-BCIS) (2000-2008). Europe (incl. UK): Proton Seventh Annual Survey Report (2009) and European Commission (2010).

3. Comparisons after adjusting for research expenditure (per \$US100m) and US dollar purchasing power parity

Source: OECD based on data and calculations from European Commission (2012), Australia's Department of Innovation, Industry, Science and Research (2011), US Association of University Technology Managers (AUTM) (2008)-(2012), Canadian AUTM (2008)-(2012)

What other topics relate to the interface between universities and public research institutes and innovative businesses?

Intellectual property rights and innovation in firms (see [Intellectual property rights and innovation in firms](#) [1]) and **Intellectual property rights for innovative entrepreneurship** (see [Intellectual property rights for innovative entrepreneurship](#) [2]). The IP system influences incentives for researchers and universities to engage in patenting and commercialisation activities. For instance, the adoption in many countries of legislative policies similar to the Bayh-Dole Act, which grants universities ownership over intellectual property, can encourage universities to patent and license academic inventions.

R&D and other investments in innovation (see [R&D and other investments in innovation](#) [3]). Collaboration with universities can be particularly important for innovative businesses, since it may help them to compensate for limited internal resources that constrain their capacity to invest in formal R&D.

Markets for technology (see [Markets for technology](#) [4]). Markets for technology are critical for universities to commercialize their inventions and interact with companies. They do not have the business and production facilities that companies have to develop innovations based on their inventions. Universities and public research centres are important suppliers in markets for technology.

Firms' access to labour for innovation (see [Firms' access to labour for innovation](#) [5]) and **Access to labour for innovative entrepreneurship** (see [Access to labour for innovative entrepreneurship](#) [6]). Innovative businesses can draw on co-operation with universities to get access to highly skilled labour, such as scientists and experts, and to undertake innovation activities. Cooperation will, however, depend on sufficient skills on the side of innovative companies to engage in effective co-operation with universities.

Business support infrastructure (see [Business support infrastructure](#) [7]). For university spin-offs, the business support infrastructure is particularly relevant. As researchers may not have the background in management required to bring ideas to the market, private or public consultants (e.g. incubators or accelerator programs) may provide valuable assistance in the commercialization process.

What policies relate to the interface between universities and public research institutes and innovative businesses?

Interactions between university and industry have been driven by multiple factors, including:

- greater autonomy granted to universities in many OECD countries
- the adoption in many countries of legislative policies similar to the Bayh-Dole Act, which grants universities ownership over IP and provides them with incentives to patent and license academic inventions
- the rising costs of scientific research and budgetary pressures on universities, which encourage universities to seek new sources of revenue and engage in partnerships to share risks
- the rise of regional government efforts to foster economic development around knowledge-based clusters
- increasing demand from the business sector to collaborate with or contract research to universities.

However, industry cooperation with universities is not straightforward. Transaction and search costs for identifying adequate partners can be very high. Besides, the potential benefits that innovative entrepreneurs can derive from interactions with universities may be mitigated by several factors, including a lack of infrastructure for knowledge generation and transfer (e.g. universities and science parks) and a lack of capabilities in firms to absorb external knowledge (e.g. workforce skills for identifying and collaborating with partners, and using external information about promising markets and technologies). In addition, a mismatch between the research orientations of firms (short-term, applied R&D) and universities (long-term, basic R&D) can be an barrier for collaboration.

Public policy can influence university-industry interface by:

- **Providing legislative and administrative framework that encourages universities to commercialise their IP.** Nonetheless, the most effective system for IPR commercialisation is still commonly debated (see [Intellectual property rights and universities and PRIs](#) [8]).
- **Providing incentives for researchers in universities to disclose their ideas and inventions.** Monetary mechanisms (e.g. a fixed rate of revenues generated from the exploitation of IP) and non-monetary mechanisms (e.g. access to research funding) can also be introduced to influence knowledge disclosure behaviour by researchers. This also requires that rigidities in labour contracts for researchers employed by the public sector be overcome.
- **Building institutional capacities for universities to strengthen their links with business through bridging and intermediary organisations.** Governments, sub-national governments and universities can stimulate the formation of a range of bridging institutions, such as Technology Transfer Offices (TTO), business innovation centres, science parks and technology hubs, Industry Liaison Offices (ILO), proof of concept centres and IP-based companies or government-backed patent funds that match supply and demand for intellectual property.
- **Promoting open access to public research data.** Research policies that encourage greater openness and access to public research results may potentially allow for greater participation in public research and greater exploitation of the results, whether through commercial or other channels. The exploitation of research through new open science channels (e.g. open access databases) may also lead to downstream commercialization and innovation.
- **Business capacity developments as a qualifying condition for cooperation:** an effective industry-university interface will only take place if the internal capabilities of businesses are strengthened. Lack of motivation and capacities on the part of the private sector often proves to be the most important barrier to industry-university collaboration. Skills development or innovation purchasing initiatives can address this need, as can staff exchanges and secondments (OECD, 2010).

What policies regarding ICTs are specific to innovative entrepreneurship?

To specifically support innovative entrepreneurship, policy can:

- **Ease access for start-ups to inventions and technology developed within universities.** Unlicensed patents could be offered to start-up companies on favourable terms, with reduced cost and red tape.
- **Provide support for university spin-offs to bridge the gap between technological invention and commercial innovation.** Support for university spin-offs can take the form

of financial support (e.g. “proof-of-concept” support for testing the technical and commercial viability of early-stage innovative ideas, pre-competitive research support, seed funding programmes) and non-financial support (e.g. access to university infrastructure and services).

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