Promoting University-Industry Collaboration in Developing Countries

Collaboration between academia and industry is increasingly a critical component of efficient national innovation systems. It is useful to examine the experience of developed countries to better understand the different types of university-industry collaboration, motivations to form these agreements and barriers to cooperation, as well as the role of public policy in fostering such linkages. Developing countries face even greater barriers to such alliances, calling for a differentiated approach to promoting university-industry collaboration.

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Introduction
Collaboration between universities and industries is critical for skills development (education and training), the generation, acquisition, and adoption of knowledge (innovation and technology transfer), and the promotion of entrepreneurship (start-ups and spin-offs). The benefits of university-industry linkages are wide-reaching: they can help coordinate R&D agendas and avoid duplications, stimulate additional private R&D investment (additionality effect), and exploit synergies and complementarities of scientific and technological capabilities. University-industry collaboration can also expand the relevance of research carried out in public institutions, foster the commercialization of public R&D outcomes, and increase the mobility of labor between public and private sectors. The benefits of university-industry collaboration are also evident in developing countries. For example, a study in Chile and Colombia shows that collaboration with universities substantially increased the propensity of firms to introduce new products and to patent (Marotta, Blom, and Thorn 2007).

The many types of university-industry links have different objectives, scopes, and institutional arrangements (see Table 1). Collaboration may be more or less intense and may focus on training or research activities. Collaboration may be formal or informal, from formal equity partnerships, contracts, research projects, patent licensing, and so on, to human capital mobility, publications, and interactions in conferences and expert groups, among others (Hagedoorn, Link, and Vonortas 2000). Also it is useful to differentiate between short-term and
long-term collaboration. Short-term collaborations generally consist of on-demand problem solving with predefined results and tend to be articulated through contract research, consulting, and licensing. Long-term collaborations are associated with joint projects and public-private partnerships (including private-funded university institutes or chairs, joint university-industry research centers, and research consortia), often allowing firms to contract for a core set of services and to periodically re-contract for specific deliverables in a flexible manner. Longer term collaborations are more strategic and open-ended, providing a multifaceted platform where firms can develop a stronger innovative capacity in the long run, building upon the capabilities, methods, and tools of universities (Koschatzky and Stahlecker 2010).

Table 1: A typology of university-industry links, from higher to lower intensity

<table>
<thead>
<tr>
<th>High (Relationships)</th>
<th>Research partnerships</th>
<th>Inter-organizational arrangements for pursuing collaborative R&amp;D, including research consortia and joint projects.</th>
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<td></td>
<td>Research services</td>
<td>Research-related activities commissioned to universities by industrial clients, including contract research, consulting, quality control, testing, certification, and prototype development.</td>
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<td></td>
<td>Shared infrastructure</td>
<td>Use of university labs and equipment by firms, business incubators, and technology parks located within universities.</td>
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<tr>
<td>Medium (Mobility)</td>
<td>Academic entrepreneurship</td>
<td>Development and commercial exploitation of technologies pursued by academic inventors through a company they (partly) own (spin-off companies).</td>
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<td></td>
<td>Human resource training and transfer</td>
<td>Training of industry employees, internship programs, postgraduate training in industry, secondments to industry of university faculty and research staff, adjunct faculty of industry participants.</td>
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<tr>
<td>Low (Transfer)</td>
<td>Commercialization of intellectual property</td>
<td>Transfer of university-generated IP (such as patents) to firms (e.g., via licensing).</td>
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<td></td>
<td>Scientific publications</td>
<td>Use of codified scientific knowledge within industry.</td>
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<tr>
<td></td>
<td>Informal interaction</td>
<td>Formation of social relationships (e.g., conferences, meetings, social networks).</td>
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Source: Adapted from Perkmann and Walsh 2007, Tables 2 and 3.

Firms and universities are increasingly finding it mutually beneficial to collaborate. On one hand, private firms are progressively adopting open innovation strategies to better access and integrate external sources of knowledge, leading to a stronger interest in collaboration with universities. On the other hand, since the 1990s, the strategic mission of universities has moved beyond the tradition of teaching and research toward a “third mission” related to better addressing the needs of industry and contributing directly to economic growth and development.

The three university missions have given rise to the distinct concepts of teaching university, research university, and entrepreneurial university. University-industry collaboration may take place under all of these university regimes, although it will have a distinct focus on training in the teaching university, on R&D in the research university, and on technology commercialization.
and spin-offs in the entrepreneurial university. In any case, complementarities exist among the different university-industry links. For example, agreements to develop joint research may give rise to opportunities for training doctoral students. Likewise, collaboration in research may lead to the creation of spin-off companies or to the licensing of patents.

**Different priorities at different stages of economic development**

The priorities and scope of university-industry collaboration differ significantly between developed and developing countries, as shown in Table 2. In developing countries, a major concern is the poor quality of education and the lack of financing available to universities, which often indicate insufficient capacity to join industry in innovation-related projects. Building effective university-industry linkages in this context takes time and sustained effort, in part because universities in developing countries generally have little experience in industry collaboration and limited managerial capacity in research. Existing collaboration tends to be more informal and to focus on the firms’ recruitment of university graduates for staffing, internships, and consulting. The research activity of universities is less likely to lead to spin-offs or patents that can be commercially exploited. In many developing countries university-industry collaboration is constrained by historically based cultural and institutional barriers, which take time to overcome.

**Table 2: Priorities for university-industry partnerships at different stages of economic development along the three missions of universities**

<table>
<thead>
<tr>
<th>Most developed countries</th>
<th>Least developed countries</th>
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<tbody>
<tr>
<td><strong>Teaching University</strong></td>
<td><strong>Research University</strong></td>
</tr>
<tr>
<td>• Private participation in graduate programs</td>
<td>• Research consortia and long term research partnerships to conduct frontier research</td>
</tr>
<tr>
<td>• Joint supervision of PhD students</td>
<td></td>
</tr>
<tr>
<td><strong>Teaching University</strong></td>
<td><strong>Research University</strong></td>
</tr>
<tr>
<td>• Curricula development to improve undergraduate and graduate studies</td>
<td>• Building absorptive capacity to adopt and diffuse already existing technologies</td>
</tr>
<tr>
<td>• Student internships</td>
<td>• Focus on appropriate technologies to respond to local needs</td>
</tr>
</tbody>
</table>

Universities act as an important driver of economic development and catching-up through their role in education and technology absorption, adaptation, and diffusion (Yusuf 2007). Beyond the teaching-research-entrepreneurial taxonomy, some authors have advocated for shifting the focus toward creating *developmental universities* which collaborate with external agents, (including firms) not necessarily with a focus on commercialization and profit-making but rather with the broader purpose of contributing to social and economic development (Brundenius, Lundvall, and Sutz 2009).
Along these lines, a specific role for universities in developing countries would be to foster innovation and learning in the informal sector, which represents the main source of income for a large proportion of the population. The aim would be to promote a shift toward more formal, innovative, and inclusive businesses, which would ultimately drive economic growth and employment.

**Motivations and barriers for collaboration**

Successful industry-university collaboration needs to support the missions and motivations of each partner. For universities, typical motivations to collaborate with industry include the improvement of teaching, access to funding, reputation enhancement, and access to empirical data from industry. For firms, the motivations to collaborate with universities may include gaining access to complementary technological knowledge (including patents and tacit knowledge), tapping into a pool of skilled workers, providing training to existing or future employees, gaining access to the university’s facilities and equipment, gaining access to public funding and incentives; firms may also seek to reduce risks by sharing the costs of R&D, and to influence the overall teaching and research agenda of universities.

Despite the growing strength of these motivations, many barriers to university-industry collaboration persist, including the following:

- There is an inherent mismatch between the research orientations of firms and universities, with an excessive focus on fast commercial results in firms and on basic research in universities. Collaboration is costly and the returns only accrue in the medium to long run, but firms seek short-term results and clear contributions to current business lines.

- In terms of outputs, firms are usually interested in how quickly new patents or new products can be obtained, and want to delay publications to avoid disclosing information. University researchers, in contrast, are typically motivated to publish research results as fast as possible.

- Industry is concerned about secrecy and misalignment of expectations with regard to intellectual property (IP) rights and making a profit from them. Thus agreements need to be established in a commercially timely manner that ensures the ability to commercialize with appropriate returns.

- Difficulties in negotiating a collaboration include lack of information, difficulties finding contact persons, and transaction costs of finding the right partner, among others.

In view of these obstacles to university-industry collaboration, a report of the Joint Project of the U.S. National Council of University Research Administrators and the Industrial Research Institute recommends the following guiding principles for university-industry endeavors (NCURA 2006):

- Successful university-industry collaboration should support the mission of each partner. Any effort in conflict with the mission of either partner will ultimately fail.
• Institutional practices and national resources should focus on fostering appropriate long-term partnerships between universities and industry.

• Universities and industry should focus on the benefits to each party that will result from collaborations by streamlining negotiations to ensure timely conduct of the research and the development of the research findings.

These recommendations are equally relevant for all countries, although the barriers to university-industry collaboration are especially acute in low-income countries. On the university side, there is often a lack of financial and human resources and capabilities to produce research results that can be converted into economic returns through patents, spin-offs, or other means like consulting and contracting. On the industry side, low technological capability and low interest in technological innovation limit the demand for the external knowledge that universities could provide. In the words of Wunsch-Vincent (2012, 97), “[A]bsent its own R&D capacity, the private sector cannot ‘absorb’ what is done in public research”.

Policies to promote university-industry collaboration
Public policy may influence the propensity of firms to collaborate with universities and the scope of such collaborations in many different ways - through a direct role in providing funds to universities and R&D projects, as well as through a regulatory role, which influences the rule-sets of public universities and shapes the intellectual property rights regime. Another role of public policy is to provide the necessary infrastructure and intermediate organizations such as technology transfer offices, science parks, and business incubators. Furthermore, governments can stimulate collaboration through soft measures, such as providing specific support services to firms/universities in the search for partners and conducting outreach activities to promote networking and raise awareness of the importance of collaboration.

Given these challenges and the very limited budgets and multiple competing priorities developing countries face, their governments should concentrate efforts on the most appropriate policy instruments. The following sections review policy options to promote university-industry collaboration, specifically as they relate to the case of developing countries.

R&D incentives and grants
A typical approach to stimulating university-industry collaboration is to design R&D research grants, matching grants, and tax-incentives with a requisite of a consortium of firms and universities for project eligibility. The innovation voucher is another possible instrument to promote collaboration that has been successfully tested in countries like the Netherlands, Ireland, and the UK (OECD 2010). Innovation vouchers are small lines of credit provided by governments to firms (generally small and medium enterprises) to purchase services from universities and public research centers, with a view to introducing innovations in firms' business operations. Its simplicity makes the measure easily adoptable in developing countries.

The problem in many developing countries is that firms have shown little interest in requesting grants, because they either do not feel the need to collaborate with universities, are not ready to
match the funds with internal resources, or find the grant application process too complex. More fundamentally, universities often do not provide the incentives to align their research agendas with market demands, and therefore are not very relevant to the needs of local enterprises. In Uganda a grant scheme specifically to promote university-industry collaboration was launched in 2007 with funding from the World Bank, but firms had little interest in participating in the program.

**Performance-based funding of universities and reward systems for researchers**

Governments can seek to stimulate university-industry collaboration through their role in funding public universities. The performance measures that determine the funding received by public universities normally include indicators like numbers of students, PhD graduates, scientific publications, and patents. In order to stimulate collaboration with industry, other criteria should be introduced, such as the number of consulting or R&D contracts with industry, income from patent licensing, number of spin-offs, number of start-ups by university faculty or graduates, and so on. The UK, Canada, India and Singapore governments, for example, offer universities supplementary earmarked funding for research, conditioned on the university achieving a certain level of contracts with industry, spinoffs, or start-ups (Yusuf 2007).

In addition, governments can reform the reward systems for university professors and researchers by introducing new incentives to collaborate with industry. Normally, university researchers are not rewarded in their careers for collaborating with business, and in some countries it is even seen as unethical to do so. Teaching experience and publications continue to be dominant criteria in tenure track systems and salary scales, and in most universities cooperation with industry is poorly measured and not considered in tenure tracks. To address this, a report by the Australian Advisory Council on Intellectual Property (AACIP 2012) advocates a rebalancing reconsideration of the key performance measures of public universities and research centers, developing mechanisms to increase the motivation of universities and their researchers to collaborate with industry.

Although the shift is slow, since the 2000s most OECD (Organization for Economic Co-operation and Development) countries have introduced new measures to promote and reward university researchers for developing industry linkages, such as R&D funds mobilized from private sources, earnings from consulting, income from patent licensing, and participation in spin-offs or start-ups. Another option is to provide sabbaticals for researchers to launch research-related enterprises. More broadly, any university regulations that might lead to excessive bureaucracy or unnecessary restrictions on how researchers interact with firms should be removed, whenever possible.

Emerging countries like Turkey have also redesigned in the early 2010s the academic promotion rules to introduce new incentives in addition to traditional criteria like publications. However, according to Zuñiga (2011 [5]) in many developing countries “institutional constraints such as employment rules for civil servants and bans on creating private organizations at public universities (or joint ventures with firms) limit academic entrepreneurship and the potential
exploitation of patents and other forms of IP." For example, in Thailand some firms expressed interest in building closer links with universities, but received a weak response from universities and government agencies (Brimble 2007).

**Intellectual property rights regime and technology transfer offices**

The United States pioneered in introducing new regulations to stimulate the patent activity of universities and to enable commercialization of research products. The Bayh-Dole Patent and Trademark Amendments Act of 1980 provided blanket permission for performers of federally funded research to file for patents on research products and to grant licenses for those patents to private firms. Following the U.S. experience, during the 1990s most OECD countries introduced similar legislation, and since the 2000s many low- and middle-income countries - China, Brazil, Mexico, South Africa, Malaysia and Philippines, in particular - have followed suit (Zuñiga 2011). Besides legal reforms, regulatory frameworks also include voluntary guidelines for IP management and codes of conduct in collaborative projects.

Further, the creation of technology transfer offices (TTO) in universities has become a widespread institutional mechanism to assist researchers in patenting their findings and obtaining license fees and royalties (Correa and Zuñiga 2013). TTOs provide a wide array of services aimed at improving the technology transfer cycle, such as support in the patent application process, licensing agreements, search for partners and funding sources, and training and support in the creation of university-based spin-offs.

But IP reform and commercialization efforts cannot compensate for a country’s weak national innovation system. Sustained efforts in R&D to develop the appropriate technological capabilities and linkages are required before relevant returns appear in the form of commercially successful spin-off companies or patent licensing. Thus, in developing countries, the results of IP reform tend to be disappointing (Brundenius, Lundvall, and Sutz 2009; Zuñiga 2011) because of the low technological capacities of universities (in terms of both human capital and infrastructure), the limited awareness of the benefits of IP among researchers and firms, the lack of interest among firms in technological development, and overall institutional weaknesses.

**Science parks, spin-offs, and business incubators**

National governments can further shape university-industry links by developing science parks in the vicinity of universities and by spurring university research spin-offs and start-ups with university connections, for example through public venture capital and grants to entrepreneurs. Science parks are intended to create clusters and promote collaboration between firms and research institutions, and they often include business incubators to support spin-off and start-up companies.

The number of science park initiatives has exploded in both developed and developing countries, although examples of failure abound where ambitious science parks turned into no more than real estate players with unsustainable financials. In particular, there is a lack of compelling evidence of success of these initiatives in low and middle income countries. Yusuf (2007) points out numerous examples of such failed attempts in China.
Despite the potential benefits of science parks and university spin-offs, not all regions and countries have the necessary endowments to achieve success in developing science and technology parks. Governments that aim to create these research clusters are advised to be cautious and to design the park in accordance with a realistic assessment of the expected results in a given context.

**Education and training**

For the majority of firms, the most important link to a university is through recruitment of skilled graduates. Education and training remains one of the key roles of universities, especially in lower income countries where the lack of skilled workers is a major bottleneck hindering the competitiveness and innovative capacity of firms. Governments may seek to improve the quality of university graduates by fostering a stronger collaboration of universities with industry. A first step is to establish a consultative process whereby the voice of relevant business managers is considered in curriculum development, so that university programs better respond to industry needs.

Governments can also establish and support student internship programs for undergraduates, as well as seek the participation of firms in graduate programs, and even the joint supervision of PhD students, who may undertake part of their research within firms. For example, in Chile, within the context of the Science for the Knowledge Economy Project financed by the World Bank (2003–07), the government offered scholarships for PhD students and young researchers to conduct their research in firms. The aim was to enhance knowledge diffusion from public R&D institutes and universities to the private sector (especially SMEs) and to improve employment possibilities and broaden the career paths of young researchers. Following up on the scholarships, many young researchers were offered long-term employment in the firms, leading to an enduring increase in the private sector’s R&D capacity.

**Globalization and university-industry collaboration**

National innovation systems in most countries are becoming more integrated with global innovation networks and more dependent on foreign sources of knowledge. Collaborations between local industry and foreign universities can play a critical role in the absorption and adaptation of knowledge developed abroad, as illustrated by the contribution of U.S. universities to the modernization of the salmon industry in Chile.

The globalization of innovation brings both opportunities and challenges for developing countries. Multinational companies (MNCs) have substantially expanded their global innovation networks, and their aim to collaborate with universities located abroad has been identified as one of the main drivers of the internationalization of their R&D centers. Policy makers should strive to stimulate collaboration between multinational subsidiaries and local universities as a mechanism to attract their R&D activity and to enhance local learning and technology transfer. Since the 2000s, a growing proportion of these offshore R&D centers have been located in developing countries, but benefits will only accrue if the appropriate conditions, including human capital, universities and public research institutes, clusters of innovative local firms, and innovation-friendly regulatory regimes are in place. From a different angle, large firms from
developing countries may choose to collaborate with foreign rather than local universities if their home country universities lack research qualifications.

As universities also become globalized, a growing number of leading universities from developed countries are opening up campuses in developing countries to provide training in situ or to engage in R&D. This allows universities to globally leverage their reputation, knowledge base, and management practices. Sometimes, their decision to locate in developing countries is driven by generous funding from local governments and international donors. An example is the Georgia Institute of Technology, one of the top U.S. research universities that has established new campuses and R&D centers in France, China, Costa Rica, Ireland, and Singapore. Another example is the new campus of Carnegie Mellon University in Rwanda, launched in 2011 with funding from the Rwandan Government and the African Development Bank. This was the first high-ranked American university to open a full-fledged campus in Africa.

Attracting foreign universities represents an opportunity for developing countries to develop the potential for international technology transfer and diffusion, as well as to bolster the learning and demonstration effect on local universities. Moreover, these satellite campuses and R&D centers often explicitly seek close collaborations with local firms in technology generation and diffusion. However, these developments may also entail some risks in terms of crowding-out national universities and research institutes in the home country, which may receive less public funding and face greater difficulties in attracting talented researchers and students.

Conclusions
The most appropriate approach to promoting university-industry collaboration depends on the country’s technological and institutional endowments and its willingness to consider the promotion of university-industry linkages as part of a broader science, technology, and innovation policy program.

The challenge for governments is to select policy instruments that best serve national needs, in consultation with key stakeholders. Facing limited budgets, governments along with firms and universities must make complex choices between collaboration in education or in research, between university collaboration with established firms (marching grants, consortia) or new firms (spin-offs, incubators), and between providing grants or developing science parks, among other factors.

While this policy brief has offered a review of the main policy options available, more empirical evidence on the success of specific policy programs to support university-industry collaborations in developing countries is needed.

References


