The contribution of academic research to innovation and growth

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The contribution of academic research to innovation and growth

Reinhilde Veugelers (KUL)

Abstract

To better understand how academic research can contribute to innovative growth and to assess how Europe is and could be doing in this respect, we review the analysis and evidence of business science links and Europe's record on this.

The evidence and analysis shows that the link between science and industry is neither direct nor obvious. When looking at the evidence for Europe, there is a general lagging behind relative to the US, particularly on academic patenting and university spin-offs. Patenting and licensing is only two of a number of pathways for the transfer of knowledge from universities to industry, and perhaps not even the best forms. Student & researchers' mobility from academe to industry is a critical mechanism to transfer knowledge from the university to industry, particularly when the knowledge to be transferred is hard to codify and is embodied in human capital as is the case for science-based knowledge. Although this is an area of great importance to the study of the innovation process, only recently research has started to attempt to trace researchers' intersectoral mobility

When looking for ways to improve the transfers from science to innovation, most of the attention in the academic literature and policy is on finding the critical success factors on the science side. Most of this analysis looks at academic patenting and faculty spin-offs and comes from best US practices. These include proper intellectual property right regimes, where Bayh-Dole type of reforms which allocate property rights to the university, are considered to have cleared the path towards tech transfer in the US. Other best practices include having in place incentive schemes for tech transfers, with a fair share for researchers in royaltees and spin-offs and having in place a dedicated technology transfer office, which critical scale, expertise and experience in mediating technology transfer. But perhaps the most important success factor for tech transfer identified is the quality of the research faculty and their created ideas.

Overall, the most salient policy recommendations that stems from the analysis is that policy makers looking for ways to improve the contribution of universities to innovation based growth, should take a long-term perspective for developing an industry-science eco-system, avoiding the temptation of quick "success stories". A particular dangerous policy practice is a target focusing only on the commercialization of university technologies through academic patenting and spin-offs, ignoring the broader contribution to economic development with other pathways, most notably the research based training and mobility of human capital from universities.

Policy makers should be more "innovative" in their search for effective policy interventions, venturing beyond the classic spin-off and incubator programs. At the same time, they should be more serious about evaluating their new and existing instruments. To progress, policy makers

should support more systematic data collection and analysis on the various pathways for universities’ contribution to economic prosperity.

Contribution to the Project

The policy paper will contribute to assessing the potential contribution of academic research as well as research excellence to achieve the envisioned new European growth path, directed at making closer links with industrial research and hence industrial competitiveness.

Keywords:

Academic research, Clusters, Innovation, Innovation policy, New technologies, Patents, Research

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The contribution of academic research to innovation and growth

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Executive Summary

As European economies worry about their economic recovery and future growth prospects in a rapidly changing world economy, their attention naturally turns to academic research as a valuable assets for economies. Increasingly, governments are looking for a more direct and larger-scale involvement of academic research in knowledge based growth. To better understand how academic research can contribute to innovative growth and to assess how Europe is and could be doing in this respect, we review the analysis and evidence of business science links and Europe's record on this.

The evidence and analysis shows that the link between science and industry is neither direct nor obvious. The evidence also emphasizes the large time lags required, the differential impact depending on the innovative system's position relative to the technological frontier, the differential effects for subsets of technological fields and the importance of geographic proximity for spillovers to occur.

When looking at the evidence for Europe, there is a general lagging behind relative to the US, particularly on academic patenting and university spin-offs. Patenting and licensing is only two of a number of pathways for the transfer of knowledge from universities to industry, and perhaps not even the best forms. Student & researchers' mobility from academe to industry is a critical mechanism to transfer knowledge from the university to industry, particularly when the knowledge to be transferred is hard to codify and is embodied in human capital as is the case for science-based knowledge. Although this is an area of great importance to the study of the innovation process, only recently research has started to attempt to trace researchers' intersectoral mobility

When looking for ways to improve the transfers from science to innovation, most of the attention in the academic literature and policy is on finding the critical success factors on the science side. Most of this analysis looks at academic patenting and faculty spin-offs and comes from best US practices. These include proper intellectual property right regimes, where Bayh-Dole type of reforms which allocate property rights to the university, are considered to have cleared the path towards tech transfer in the US. Other best practices include having in place incentive schemes for tech transfers, with a fair share for researchers in royaltees and spin-offs and having in place a dedicated technology transfer office, which critical scale, expertise and experience in mediating technology transfer. But perhaps the most important success factor for tech transfer identified is the quality of the research faculty and their created ideas. This is a strong reminder of the importance of the universities' core mission as creators of fundamental curiosity driven research for industry science links.

Overall, the most salient policy recommendations that stems from the analysis is that policy makers looking for ways to improve the contribution of universities to innovation based growth, should take a long-term perspective for developing an industry-science eco-system, avoiding the temptation of quick "success stories". A particular dangerous policy practice is a target focusing only on the commercialization of university technologies through academic patenting and spin-offs, ignoring the broader contribution to economic development with other pathways, most notably the research based training and mobility of human capital from universities.

Policy makers should be more "innovative" in their search for effective policy interventions, venturing beyond the classic spin-off and incubator programs. At the same time, they should be more serious about evaluating their new and existing instruments. To progress, policy makers should support more systematic data collection and analysis on the various pathways for universities' contribution to economic prosperity.

1. INTRODUCTION

The policy paper will contribute to assessing the potential contribution of academic research to achieve a new European growth path, directed at making closer links with industrial research and hence industrial competitiveness. A core element will be to critically examine business-science links in Europe and to suggest ways of improving them

To better understand how academic research contributes to innovative growth, this paper first looks at the economic frameworks that allow to study the impact of academic research on economic growth and innovation (section 2). The macroeconomic and microeconomic evidence that exists on the contribution of academic research to growth and innovation is reviewed in section 3. Section 4 zooms in on the mechanisms and institutions that may help to stimulate industry science links. Intellectual property right regimes, incentive schemes and technology transfer offices are examined in this section. Section 5 looks at the evidence on the different pathways through which universities impact innovation and growth. To this end it not only looks at university patenting and faculty spin-offs, but also includes other pathways, most notably the human capital component of training of graduates and researchers. Section 6 looks at the evidence on which policy instruments are most promising for improving industry science links. Some concluding policy recommendations close this contribution.

2. FRAMEWORKS FOR ANALYSING THE CONTRIBUTION OF ACADEMIC RESEARCH TO INNOVATION AND GROWTH

A multitude of economic studies have shown the importance of academic research for technology, innovation and economic growth (e.g. Allen, 1977; Tushman, 1977; Tushman & Katz, 1980; Jaffe, 1989, Adams, 1990, Narin et al 1997, Griliches, 1998, Rosenberg & Nelson 1994; Mansfield, 1995; Henderson et. al. 1998; Branscomb et al., 1999, Cohen et al 2002). The technology management literature has documented the process of how scientific knowledge feeds into successful innovations and consequent economic growth mainly on the basis of specific case studies and detailed surveys at the firm-level (e.g. project Hindsight, 1958, project TRACES, 1967; Tushman, 1977; Tushman & Katz, 1980; Bud, 1994; Hills, 1997). However, a coherent body of theory and insight into the multifaceted nature of the links between science and markets is still lacking (Stephan, 1996).

There are basically two main frameworks used in the literature to analyse the contribution of academic research to innovation. These are (i) endogeneous growth theory and (ii) the National Innovation Systems/Triple Helix. The next two sections will give a short overview of these two frameworks.

2.1. ENDOGENEOUS GROWTH THEORY

The theory of endogenous growth, pioneered by Romer (1990), Aghion and Howitt (1998) and Grossman and Helpman (1991) provides a theoretical framework to understand the relationship between basic research and growth.

The majority of studies based on endogenous growth theory (Romer, 1990; Lucas, 1988; Grossman and Helpman, 1991 and 1994; Aghion and Howitt, 1998) suggest that a key role in economic development is played by technological progress and the commitment of resources to innovation.

Particularly at the frontier of technological progress, the connection with fundamental research, typically done in universities becomes crucial. The type of human capital needed to pursue frontier pushing research is also different: genuine "inventors" are needed. Often, such inventors come from or are close linked to fundamental research in universities. Their productivity in the invention process depends on the quality of their education (Aghion et al 2009).

Vandenbussche et al. (2006) propose an extended model of endogenous growth to capture these effects. Within the innovation sector, they draw a distinction between innovation and imitation activities, and incorporate in their model the important fact that innovation requires more human capital (education) than imitation. Making use of these results, they study the impact of an increase in the education level. They show that investing in higher education (high skills) "*enhances productivity growth all the more the economic is closer to the world technological frontier*.

In most endogenous growth models based on research and development, the stock of human capital is taken to be exogenously determined. More recent papers, notably Acemoglu (1997) and Redding (1996), have relaxed this assumption, and considered what happens when individuals can choose to make investments in education or training, while firms make investments in R&D. For some parameter values, multiple equilibria are possible, since the incentives of workers to invest in human capital, and those of firms to invest in R&D, are interdependent. This provides a way of formalising earlier ideas about the possible existence of a "low-skill, low-quality trap" in which low skill levels and slow rates of innovation reflect a co-ordination failure. The models suggest that, at the aggregate level, greater investment in education or training might raise expenditure on private R&D, and vice versa.

2.2. NATIONAL INNOVATION SYSTEMS

The concept of 'innovation systems' has gained widespread acceptance since the mid-1980s. The "innovation systems" approach stresses the role of, and the interplay between, different types of innovation actors for understanding the dynamics behind innovative performance, growth and competitiveness of nations (e.g. Freeman, 1987, 1991; Adams, 1990; Lundvall, 1992; Nelson, 1993; Mowery and Nelson,1999; Baumol, 2002).

In these models, universities are considered as relevant and distinctive actors, contributing to the innovative potential of societies. This holds particularly for basic research, which is characterized by high levels of technological and market uncertainties and long lead times. Private investors tend to refrain from basic research, leaving universities and public research institutes uniquely positioned to produce science-based knowledge upon which the development of new products, processes and services can build.

At the same time, an effective contribution to the capacity of an innovation system requires that universities not only create ideas that can be commercialized, but also that they are willing to become involved in the process of transferring research ideas towards commercial success. The notion of 'entrepreneurial universities' (Branscomb, Kodama & Florida, 1999; Etzkowitz, Webster & Healy, 1998) refers to universities becoming more active in the transfer of research results through patent and license activities, spin-off activities, collaboration projects with the industry, and greater involvement in economic and social development as a whole.

Companies – in employing more open innovation strategies (Chesbourgh 2003) have been looking more closely at university laboratories as contributors to their research and product development activities. Academic research rarely produces "prototypes" of inventions that can be readily used by industry for development and commercialization. Instead, academic research informs the methods and disciplines employed by firms in their R&D facilities. Firms that rely on scientific research findings are expected to develop a deeper understanding of the technological landscapes in which they search for new inventions. It allows them to better anticipate, evaluate and translate the outcomes of their technology activities (Rosenberg, 1990; Fleming and Sorenson, 2004).

As academic research and innovation are typically developed in separate organisational structures, the first typically in universities and public research organisations, the second in private enterprise, a critical characteristic of national innovation systems is how well the different types of actors are interconnected and knowledge flows between them. There are various pathways for industry and science to interact. These include formal relationships, such as collaborative agreements between science and industry, R&D contracting, own licensing policies and intellectual property management and spin-off activities of science institutions. But behind this multitude of formal relationships lies a myriad of informal contacts, gatekeeping processes, personnel mobility and industry-science networks on a personal or organizational base. These informal contacts and human capital flows are ways of exchanging knowledge between enterprises and public research – creating spillovers - and are more difficult to quantify, but nevertheless extremely important and often a catalyst for instigating further formal contacts.

There are some industries where the link between science and innovation is explicit and direct. Industries such as biotechnology, pharmaceuticals, organic and food chemistry are "science-based" in the classic sense and rely heavily on advances in basic research to feed directly into their innovations (Levin et al. 1987). In non-science based industries much innovation also derives from other-than-basic-research related activities. Nevertheless, even here innovation may be facilitated by better use of basic research resources, such as the training of skilled researchers helping to increase the absorptive capacity of industry.

3. EVIDENCE ON THE CONTRIBUTION OF ACADEMIC RESEARCH TO INNOVATION AND GROWTH

3.1. THE CONTRIBUTION OF ACADEMIC RESEARCH TO CORPORATE INNOVATION: MACRO-EVIDENCE

A multitude of economic studies has shown the importance of *basic research* for technology, innovation and economic growth (e.g. Allen, 1977; Tushman, 1977; Tushman & Katz, 1980; Jaffe, 1989, Adams, 1990, Narin et al 1997, Griliches, 1998, Rosenberg & Nelson 1994). When empirical studies in the spirit of endogeneous growth theory perspective attempt to separate out the economic impact of publicly funded research on (total factor) productivity growth, a large positive contribution is usually identified (e.g. Lichtenberg, 1993, Coe and Helpman, 1995).

Guellec and Van Pottelsberghe de la Potterie, 2004) provides an analysis for 15 OECD economies in the period 1980-1998. The authors calculate measures of the total public R&D capital stock stemming from R&D performed in the public sector. They estimate the a long-term responsiveness (elasticity) of multi-factor productivity with respect to public research which is positive and higher than the response to private sector research (the long run elasticity, or 'responsiveness', being 0.17 for public compared to 0.13 for private). This reflects that publicly funded research is more concerned with basic research and is associated with a higher degree of spillovers to the rest of the economy. They also show that the responsiveness of multi-factor productivity with respect to public sector research is higher when business R&D intensity in the economy is higher. This emphasises the complementarity between public research and investment in the business sector. Without absorptive and innovative capacity in the business sector, the ability to capitalise on opportunities arising from public research will be limited. This highlights the essential importance of considering the impact of public sector research along with complementary investments by other sectors of the economy. Guellec and Van Pottelsberghe de la Potterie also show that the impact of public sector R&D is positively affected by the proportion accounted for by university research. This is not the case for public sector laboratory research. They speculate that government performed R&D may be more focused on targeted areas, such as public health, environment and defence issues, and hence is less likely to directly impinge on measured GDP growth. Finally, the impacts are achieved within a three-year periods. These time-lags appear remarkably short, compared to the findings from micro-analysis (cf infra).

There have been a number of attempts to estimate the impact of public sector funding on public sector R&D at the level of individual sectors or fields of research. Most of these studies were US-based, with the early ones often being concerned with agricultural research. They yielded rates of return to public R&D expenditure of typically between 20% and 67% (Salter and Martin (2001)). This is a very substantial impact for public sector R&D in those specific industry or country cases. In the industry studies reviewed in Salter and Martin (2001) calculating estimated rates of return to publicly funded R&D, the effects occur with long and variable time-lags. Although these time-lags appear to be shortening over time, they still fall within the range of six to 15 years. Studies at the industry level, moreover, indicate that there are very wide variations in the ways in which, and the rate at which, knowledge is exchanged between the publicly funded research sector and private enterprise.

Cincera et al. (2009) develop an empirical methodology for assessing the efficiency of the main policy instruments open to government to support R&D activities in the private sector. They distinguish between direct subsidies and tax incentives as supporting policies alongside R&D performed in the public sector. They also distinguish between the higher education and government sectors. Using stochastic frontier analysis, they show that higher education expenditure on R&D has a positive and significant impact on private sector R&D and on the number of R&D personnel employed in the business sector.

3.2. THE CONTRIBUTION OF ACADEMIC RESEARCH TO CORPORATE INNOVATION: MICRO-EVIDENCE

The technology management literature has documented the process of how scientific knowledge feeds into successful innovations and consequent economic growth mainly on the basis of specific case studies and detailed surveys at the firm-level (e.g. project Hindsight, 1958, project TRACES, 1967; Tushman, 1977; Tushman & Katz, 1980; Bud, 1994; Hills, 1997. Empirical evidence from surveys of corporate and academic researchers (Mansfield, 1995, 1996, 1997;

Cohen et al, 2002, Veugelers & Cassiman 2005) confirm the importance of basic research for corporate innovation performance.

The micro-econometric literature uses various proxies to quantify knowledge transfers from academic research through various proxies. Shane (2002) investigated licensing of university generated innovations. Other papers have examined academic spin-off activities (Shane 2002, Zucker et al. 1998; Audretsch & Stephan 1996; Utterback et al, 1983). Henderson et al. (1998) looked at citations to academic patents, Siegel et al. (2003) at university science parks, while a paper by Branstetter (2003) uses citations in corporate patents to scientific literature.

In this empirical literature university-industry collaborative research has received substantial attention (Hall, Link & Scott 2000; Cockburn & Henderson 2000; Mohnen & Hoareau 2003; Belderbos, Carree and Lokshin, 2004; Belderbos et al, 2004; Veugelers & Cassiman 2005). Most of this literature focuses on which companies are engaged in industry-science R&D cooperation. These are typically larger firms, and firms in science based industries (like biopharmaceuticals and ICT). Also firms with a stronger own R&D capacity, as an own absorptive capacity is needed to turn the link with science into improved innovative performance. Also firms with a wider set of collaborative partners in their industry, are more likely to be collaborating with science, indicating the importance of a network of partners to exploit complementarities (Veugelers & Cassiman 2005); Also Belderbos et al (2004) find that spillovers received from universities not only stimulate collaboration with universities, but also R&D collaboration with other partners.

Studies on the effects of cooperation with universities on participating firm's innovative performance are less frequent. The effects on innovative performance, using European CIS data seems to show up regularly as positive for cooperating firms (eg Monjon & Waelbroeck (2003), Tether (2002)). Belderbos et al (2004) distinguish between the various types of R&D partners to assess the effects on performance (innovative performance as well as productivity growth). They find that cooperation with universities is instrumental in creating innovations generating sales of products that are novel to the market, improving the growth performance of firms. This is in contrast with other types of cooperation which only have an effect on incremental innovations, rather than more drastic innovations.

The importance of researchers' mobility, as a critical mechanism in knowledge transfer and hence, innovation, has to be mentioned. Although this is an area of great importance to the study of the innovation process, only very recently research has started to attempt to trace inter-organisational and inter-institutional labour mobility using large standardized databases (o.a. Breschi & Lissoni 2007, Sauermann & Roach (2013)[1].

4. INDUSTRY SCIENCE LINKS: IMPEDIMENTS AND LEVERS

Although empirical studies use a variety of industry science links indicators, they all suggest an intensification of the interactions between universities and industry over time (e.g. Hall et al. 2000;Branstetter 2003). This holds particularly in important fields like biopharmaceuticals, nanotechnology, and bioengineering. (Cockburn & Henderson 2000; Zucker et al. 1998; Klevorick et al, 1995).

While on average the evidence suggests a growing trend in -and a positive effect of- knowledge transfers from science to industry, there is nevertheless a strong suggestion of an inadequate scale and intensity of such transfers, with the link between science and innovations neither direct nor close. The highly uncertain and non-codifiable nature of scientific know-how results in high transaction costs and systemic failures in the market for this know-how, explaining the difficulty of organizing industry science links. A partners' lack of understanding of the other partner's culture and conflicting objectives among partners may impede good industry science relations, notably the conflict of interest between the dissemination of new research findings versus the commercial appropriation of new knowledge (Siegel et al. 2003). Furthermore, these links are highly concentrated in a small subset of technological fields (cf supra). They also often remain geographically restricted (Jaffe, Trajtenberg & Henderson 1993; Audretsch & Stephan (1996).

In Europe, the gap between high scientific performance on the one hand and industrial competitiveness on the other hand appears particularly wide. This gap is also known as the "European paradox" (EC (2002)). A better comprehension of industry science links has thus

[1] The US STARMETRICs partnership between US science agencies (like NIH and NSF) and universities to document the outcome of public investment in research at universities, has as a major component, the impact on the career and mobility of researchers (see www.starmetrics.nih.gov)

figured high on the policy agenda in many European countries (OECD (2001), Polt et al. (2001)), Low levels of Industry Science Links (further abbreviated as ISLs) can be attributed to a lack (1) in demand at the enterprise side, i.e. a specialization on innovation paths that do not require scientific knowledge or expertise, and/or (2) of incentive structures and institutional factors at the science side. A partners' lack of understanding of the other partner's culture and *conflicting objectives* among partners may further impede good industry science relations, notably the conflict of interest between the dissemination of new research findings versus the commercial appropriation of new knowledge (Siegel et al. 2003).

Most of the academic literature looking at hampered industry science links, look at the impediments from the science side. The next sections will further look into the insights from this literature.

4.1. INTELLECTUAL PROPERTY RIGHTS REGIME

A factor which receives quite some attention as conditioning feature for smooth industry science links is a clear *intellectual property rights* regime (Link, Scott & Siegel 2003). The Bayh-Dole act in the US shifted the ownership of publicly funded research from the state to the research sector. This is widely seen as a trigger, creating stronger incentives for universities to look for commercial applications of their research (Mowery et al (2005)). Most European countries have followed suit and implemented their versions of Bayh-Dole (Van Looy (2009).

Countries also differ substantially on how the property rights are allocated within universities: i.e. to the individual researcher (professor's privilege) or the institution. Analysis shows that ownership at the institutional level is associated with higher third stream activities (Van Looy (2009)).

While the effects of the Bayh-Dole act accentuate the importance of intellectual property rights for universities for effective transfers to occur, there is also the issue of importance of clear IPR regimes to engage firms in ISL (see (Decheneux et al 2003)). Hall, Link & Scott (2001) provide qualitative evidence of the U.S. of intellectual property barriers that inhibit the formation of public-private research partnerships.

4.2. INCENTIVE SCHEMES

A major issue that universities are facing is whether researchers have sufficient *incentives* to disclose their inventions and to induce researchers' cooperation in further development following license agreements. Although the Bayh-Dole act stipulates that scientists must file an invention disclosure, this rule is rarely enforced. Instead, the university needs to have proper incentive schemes in place, specifying a share for the inventors in royaltees or equity. This is studied in Macho-Stadler et al. (1996), Jensen & Thursby (2001), Jensen, Thursby & Thursby (2003). Lach & Schankerman (2008) provide strong empirical evidence in support for the importance of inventor royalty sharing rules for university performance in terms of inventions and licence income. Analysing panel data on US universities they find that private universities with higher inventor shares have higher license incomes, as they have more inventions disclosed that can be licensed.

Beyond incentive structures involving pecuniary rewards, the non-pecuniary reward structure in place at universities rewarding and promoting researchers matter. Tenure and promotion criteria favoring teaching, research or tech transfer performance will have an impact on the efforts devoted by faculty in any of these activities.

4.3. TECHNOLOGY TRANSFER OFFICES

Bercovitz et al (2001) on a sample of US universities provide evidence of the importance of the *organisational structure* for linking up with industry. Universities with a high record in ISLs most often apply a decentralised model of technology transfer, i.e. the responsibilities for transfer activities are located close to research groups and individuals. Associated with a decentralised model is the provision of adequate administrative support which allows the researcher to concentrate on R&D efforts and knowledge exchange, leaving most administrative activities associated with transfer activities (such as legal agreements, financial issues etc.) at specialized organisational units. Furthermore, specialized support should also include the field of commercialisation of R&D results via patenting and licensing where specific legal and marketing know how is needed.

Within a decentralized model of technology transfer, creating a specialized and decentralized *technology transfer office* within the university is instrumental to secure a sufficient level of autonomy for developing relations with industry. This provides a better "buffer" against possible conflicts of interest between the commercialization and the research and teaching activities. A dedicated transfer unit also allows for specialization in supporting services, most notably management of intellectual property and business development. A higher degree of financial and managerial independence further facilitates relations with third parties, such as venture capitalists, investment bankers and patent attorneys (Debackere & Veugelers (2004)).

In addition, TTOs may have an incentive to invest in expertise to locate new inventions and sort profitable from unprofitable ones. The sunk costs to acquire this expertise can be overcome if the size of the invention pool is large enough. Using an asymmetric information framework, where firms have incomplete information on the quality of inventions, Macho et al (2004) develop a reputation argument for the TTO. The TTO being able to pool innovations across research labs, will have an incentive to "shelve" some of the projects, thus raising the buyer's beliefs on expected quality, which results in less but more valuable innovations being sold at higher prices. However, the TTO will not have enough incentives to maintain a reputation when the stream of innovations of each research lab is too small and/or the university has just a few of them. Their reputation model for a TTO is thus able to explain the importance of a critical size for the TTO in order to be successful as well as the stylized fact that TTOs may lead to less licensing agreements, but higher income from innovation transfers (Siegel et al. 2003)).

Against the benefits which a TTO can deliver, there is however the issue of scale as smaller universities often lack the resources and technical skills to effectively support such organizational arrangements and investments. In fact, universities need to produce a large number of patentable inventions every year in order to break even on their TTO activities (Scherer and Harhoff, 2000). At the same time, a separate TTO unit needs to be able to maintain close enough relationships with the researchers in the different departments. A dedicated Technology Transfer Office needs to assure appropriate incentive mechanisms with its researchers overcoming moral hazard problems to ensure generation and disclosure of research projects (see eg Jensen et al (2003)). The research on best practices at TTOs underscores the importance of identifying the interests and incentives of those who manage the technology transfer process. These studies also highlight the importance of human capital (e.g., staffing of

TTOs, "star scientists" and entrepreneurial teams) and the university culture (e.g., the role of department chairs, and entrepreneurs who are employed at these institutions) and group norms.

5. EVIDENCE ON INDUSTRY SCIENCE LINKS

As already indicated, there are multiple channels through which academic research may contribute to innovation. This section tries to provide an overview of the quantitative importance of the various channels. With its focus on providing empirical evidence, it obviously entails a bias in favor of the channels which can be more easily measured. Other helpful reviews of this vast literature are Veugelers and Del Rey, 2014, Siegel et al., 2007; Rothaermel et al., 2007; Astebro & Bazzanini 2011.

5.1. UNIVERSITY PATENTING

The trend of a more prominent role of universities in technology development and the rise of the entrepreneurial university, as discussed supra, is perhaps most notably reflected in growing number of patents generated by universities. Table 1 shows the growing share of universities as as assignees in EPO patent application[2]. Over the last three decades, the university share in patenting activity has almost quadrupled from less than 1% in the eighties, over 2% in the nineties to over 3% by 2007 (Veugelers et al , 2012). Although the share is small, the fact that it is increasing reflects that university patent application have risen faster than overall patenting activity, which has already by itself risen substantially over the considered period.

Table I. Trends in university participation in technology development

(university assignees, EPO).

[2] In this exercise, patents are allocated to the university sector when a university institute is among the assignees. This is an underestimation as is this not include the patents where university faculty are (co-)inventors on patents where the university institution is not the applicant. Research (Lissoni et al (2007) has indicated that this can be a significant share of patents, particularly in some countries like Italy. Systematically tracing these patents would however require a mapping of individual inventors to their institute of employment, which is not feasible.

Sector	1980 – 1985	1986 - 1990	1991 – 1995	1996 - 2000	2001 – 2007
Company	84,90%	87,04%	88,55%	88,42%	89,02%
Government / non-profit	2,41%	2,36%	1,98%	2,09%	2,29%
Hospital	0,07%	0,15%	0,19%	0,22%	0,19%
Individual person	11,84%	9,30%	7,70%	7,00%	5,84%
University	0,79%	1,16%	1,57%	2,28%	2,66%
	100,00%	100,00%	100,00%	100,00%	100,00%

Source: Veugelers, Callaert, Van Looy (2012)

University patenting is not only a small, albeit growing, phenomenon in the patent landscape, it is also a skewed phenomenon. Only a few countries and a few institutes account for the bulk of university patenting. Table 2 shows that 68% of all university patents are held by the United States[3]. Also only a limited number of institutes account for the bulk of university patenting. The worldwide top 25 players in university patenting, although they represent only 2,6% of all patenting universities, hold almost 40% of all university patents. US universities figure prominently with 22 institutes in the top 25: (the University of California, coming first, followed by MIT).

European countries (EU-15) take a much lower share in university patenting: 21.15%. Within Europe, the UK is the largest player, and number 2 in the world. The low share of EU-15 is due to the fact that many of its major patenting countries are only to a very limited extent active in university patenting: most notably Germany, France, the Netherlands and Italy as well as Scandinavian countries. For a number of these countries, this is a consequence of the regulations on intellectual ownership within academia. Several European countries have only recently (after 2000) abandoned the ‘professor’s privilege’ rule in favour of ‘Bayh-Dole’ oriented regulations (e.g. Germany and Denmark), while Italy has introduced the professor’s privilege (see Van Looy, 2009). In addition, in some countries – notably Germany, France and Italy – a considerable part of publicly funded research is conducted at Public Research Organisations, like CNRS, CNR, Fraunhofer, rather than at universities.

[3] Note that the figures concern EPO patents, so this prevalence holds in spite of a potential home bias for European countries.

Academic patents often represent early stage technology development, where the potential use is still unclear or uncertain (e.g. Jensen & Thursby, 2004). Furthermore, as most of the patent applications never get used, it is more important to look at those university patents that are actually being used.

One way of assessing the impact or use of university patents is to consider whether they are licensed or not (e.g. Link & Scott, 2002). License income is even more skewed than university patenting in few cases. Thursby and Thursby (2007) report that only 0.48 percent of all active licenses generated licensing income of $1 million or more in the US. Scherer and Harhoff (2000) compute that the top ten percent of all Harvard patents provided 84 percent of the gross economic value of Harvard's patent portfolio. There are spectacular returns as demonstrated by Stanford University and University of California combined licensing revenues from the Cohen-Boyer patent on recombinant DNA For the UK about 80% of the licensing returns accounted for by 20% of the cases. The top 2 cases (representing 3% of the sample) appear to have accounted for more than one third of the overall total (Russell Group, 2010).

Licensing is a rather restrictive operationalisation of valorization, as the use of the university invention requires a monetary transfer to be recorded. In addition, international comparisons of academic licensing streams is lacking. An alternative approach used in Veugelers et al (2012) to measure the "use" of university technology is to use citations from corporate patents to university patents[4]. Patent citations reveal to what extent future technology development efforts are related to the knowledge reflected in the source document as prior art for their technology developments (Jaffe et al., 1993).

Table 2: Corporate citations to university patents by country.

[4] The analysis uses EPO application data for the years 1980-2000, which allows a citation window of 10 years (until 2010). Citations are from all patent systems (USPTO, EPO…). For more information on the database and further analysis, see Veugelers et al (2012)).

Country	Country share in university patents	Country share in all corporate citations received by university patents	% university owned patents that are cited by company patents	average number of corporate citations to univ patents
US	69.8	66.8	14%	6,03
UK	9.7	6.5	15%	3,96
BE	2.9	6.2	36%	5,17
FR	2.4	2.3	28%	3,03
NL	2.2	3.0	28%	4,26
DE	1.5	1.4	22%	3,89
JP	1.4	3.8	49%	4,77
CH	0.95	1.1	23%	4,29
ES	0.66	0.9	40%	2,98
IT	0.53	0.5	21%	3,90
EU-15 (avg)	21.65	22.8	27,8%	3,74

Source: Veugelers, Callaert, Van Looy (2012)

Table 2 shows the citation-based statistics for a selection of countries. The table reveals different profiles for each of these world regions. In terms of quantity, the US is clearly dominant: it produces a large volume of university patents, leaving the EU-15 far behind. However, only a limited number of US academic patents are, in the end, cited by the corporate sector (14%). This citation rate is much higher for university patents from the EU-15 (28%) and particularly for Japan (48%). Hence, these countries have fewer but more frequently cited university patents by the corporate sector. However, when looking at the average number of citations received, conditional on being cited, the US again takes a strong lead over the EU-15 and Japan, with their university patents having a higher impact on average.

These results suggest that, in terms of profiles, the US model of university technology creation seems to be one of experimentation on a large scale. They generate a large volume of university patents, from which only a minor portion end up being 'used' in subsequent corporate technology creation. This large volume allows simultaneously for a more fertile ground for university patents to bloom into 'hits', or highly cited patents, at least for a few. This experimentation process is especially typical of the Biotechnical (Pharmaceutical) field. The profile of Europe suggests more mediocracy: universities are much less active in generating patents, only bringing out those ideas that have a relatively high probability of becoming 'used'. However, with less experimentation going on, they are less likely to result in 'high impact'. Heterogeneity in Europe, in terms of both institutional texture as well as legislative framework conditions pertaining to the ownership of publicly funded research, is partly responsible for the observed country differences (Veugelers et al (2012)) [5].

5.2. UNIVERSITY SPIN-OFFS

Spinning off is the entrepreneurial route to commercialise public research. The latter attracts a great deal of policy attention in the current wave of start-ups and new venture creation in many countries. Assessing the spin-off formation rate is often seen as a key indicator for the contribution of academic research to innovation based growth.

The determinants of university start-up activity has started to attract considerable attention in the academic literature. DiGregorio and Shane (2003) directly assess the determinants of startup formation, using AUTM data from 101 universities and 530 startups. They found that the two key determinants of start-ups are faculty quality and the ability of the university and inventor(s) to assume equity in a start-up, in lieu of licensing royalty fees. O'Shea, Allen, and Arnaud (2005) confirm these findings but find that also a university's previous success in technology transfer is a key explanatory factor of start-up formation, as well as the extent of federal science and engineering funding are also significant determinants of higher rates of university start-up formation.

Lockett, Wright and Franklin (2003) find that universities that generate the most startups have clear, well-defined strategies regarding the formation and management of spinoffs. The more successful universities have greater expertise and vast social networks that help them generate more startups.

[5] Within the EU-15, Belgium's university patents hold a top position in terms of corporate citations received. Not only do Belgian university patents have a higher probability of receiving citations by corporate patents, they also have the highest impact in Europe. The Belgian university patenting success story largely benefits from the presence of IMEC, an interuniversity centre for micro-electronics.

Lockett and Wright (2005) find a positive correlation between startup formation and the university's expenditure on intellectual property protection, the business development capabilities of TTOs, and the extent to which its royalty distribution formula favors faculty members.

Although significant research efforts have been devoted to try to measure and analyse the formation of university spin-offs, far fewer studies have looked at the growth of university spin-offs. For instance, Klepper and Sleeper (2000) show that in the US laser industry, spin-offs have outperformed other start-ups. While the survival of university start-ups is higher than for the general start-up, the survival rate of spin-offs from leading universities is even higher. Shane (2004) estimates that 80 percent of MIT spin-offs started between 1980 and 1996 survived 1997. Of the 153 spin-offs created at ETH Zurich, Switzerland, in the period 98-08, 90% survived beyond 5 years.

University-based start-ups also seem to create much more jobs than the typical start-up. AUTM data show 83 employees per spin-off during the period 1980 to 1999 while the number of employees for the typical start-up with employees is 3.8 (Shane, 2008). Other countries also show high rates of employment from spin-offs. One study for the UK found an average of 44 jobs (Charles and Conway, 2000). Blair and Hitchens (1998) estimated that the spin-offs in Northern Ireland and the U.K. employed three times the fraction of university graduates than regular firms.

5.3. STUDENT SPIN-OFFS

The empirical evidence almost exclusively covers patents and start-ups by faculty and staff. Existing empirical work (in particular all the work based on AUTM data) does not cover firms started by students because these are typically not using IP based on university funding. There are no general data on the rate by which students start up new businesses upon graduation, but there are several university-specific alumni surveys. Astebro & Bazzazian (2011) claim that student spin-offs are probably order of magnitudes larger than faculty spin-offs, at least in terms of number of firms. Their calculations for the MIT case, admittedly perhaps one of the best cases for student spin-offs, indicate a student-to-faculty spin-off ratio from 12:1 to up to 48:1 A low estimate is 12:1.

Furthermore, these student spin-offs are very likely to locate close to their Alma Mater. Using Swedish matched employer-employee records Baltzopoulus and Broström, (2009) are able to statistically estimate the effect of studying at a particular university on the probability that a student locates his/her startup in the region of the university as opposed to another region. Seventy-one percent of the entrepreneurs graduating from university start their business in the region where they were born. If the university was in the same region as they were born this probability increases to 87 percent. However, if the university where they studied was located in another region than where they were born the probability to locate in the region where they were born decreases to 26 percent. Further, among those who moved to study at a university in another region, 51 percent start up the business in the same region as the university. The university thus serves as a strong magnet to start-ups by alumni and breaks the otherwise very strong "home bias" that entrepreneurs have. Peer effects, local clusters and ties to professors seem to be behind the proximity to one's Alma Mater. In any case, student spin-offs deserve much more attention and empirical evidence and analysis than it currently receives.

5.4. SCIENCE PARKS AND INCUBATORS

The importance of proximity for transfer/spillovers of knowledge from academic research to firms motivated the construction of science parks. Science parks started to be built in the 1950s in the U.S. (e.g. Stanford Research Park and the Research Triangle Park in north Carolina) and in the late 1960s in Europe, eg Sophia Antipolis in Nice in 1969. Their numbers grew rapidly in the 1980s and 1990s.

Locating on science parks provides firms closer access to academic research in more informal ways. It may facilitate the recruiting of university (post-)graduates. For university spin-offs, a science park or business incubator provides easy access to business resources while allowing the researcher to still be in close contact with his/her lab/university position. Finally, agglomerating firms in a park/building may lead to positive spillovers between them.

The literature which evaluates the role of science parks and incubators is in its infancy. As firms self-select to join science parks and incubators, models assessing the effect from locating in science parks must account for this selection effect. For a review of this literature see Siegel, Westhead and Wright (2003). Most research on science parks fails to shows a significant impact on firm performance compared to firms not located in science parks.

A related literature on local economic effects is that on "clusters. (e.g. Audretsch and Feldman 1996; Krugman, 1991; Saxenian, 1994). Within this literature one asks whether universities can support the formation of clusters. Popular examples such as MIT and Stanford come to mind. Ellison & Glaeser (1999) show that clusters will be particularly successful in terms of knowledge spillovers when research institutes, universities and innovative companies are geographically concentrated. Also Van Looy, Andries & Debackere (2003), using evidence from various innovative regions around the world, examine the critical ingredients that can lead to regional innovation and economic success. These critical ingredients consist of a balanced mix based on the presence of research institutes, a texture of endogenous knowledge–intensive start–ups coupled to larger R&D–intensive incumbents, all of them embedded in a professional environment that supports business advice and services.

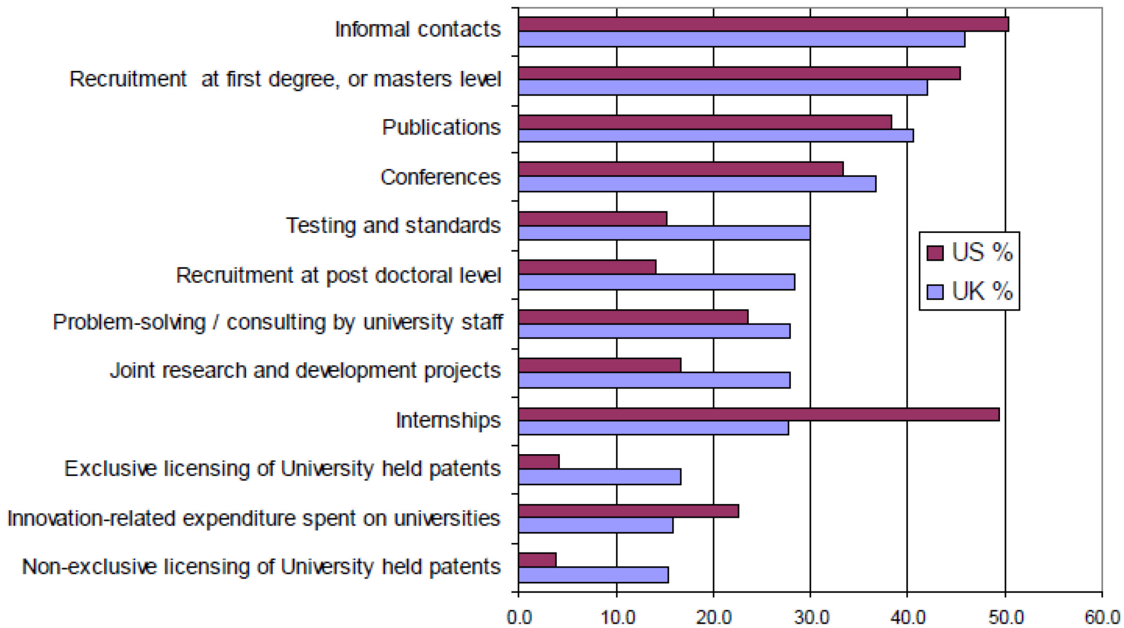
5.5. BEYOND THE TECHNOLOGY TRANSFER MODEL

Patenting, licensing and spinning off are only few of a number of pathways for the transfer of knowledge from universities to industry (Cohen, Nelson & Walsh (2002). Firms may alternatively exploit recent university research results published in the open literature; or they may use university scientists as consultants to apply well-established engineering or scientific knowledge to the development of a particular product; or they may collaborate with university scientists and engineers to apply new scientific knowledge developed by researchers at other universities; or, and perhaps most often, they may recruit the students of the leading university researchers in the field.

A UK-US survey asked the responding firms to indicate the most important types of university-industry interactions contributing to their innovation activities (Cosh et al (2006)). In both countries, informal contacts were the most important contribution, followed by recruitment at first degree or Masters level, publications and conferences. Patenting and licensing appear low down the list of business perceptions with regard to university interactions contributing to innovation.

Figure 1: Types of university-industry interactions contributing to Innovation

% of firms rating mode



Source: Cosh et al (2006)

This confirms that the best form of technology transfer is the moving van that transports the graduate or PhD from his or her university to a new job in industry. Very often the university's most important contribution is through education and training. Unfortunately this pathway remains relatively unexplored in academic work, often hampered by large scale data availability.

For many regions, technology transfer through university spin-offs or access to academic patents, will not be the most important contribution of universities to their development.

Analysis from the MIT coordinated Local Innovation Systems Projects, drawing on studies of innovation-enabled industrial change in twenty-two locations in six countries in the period 2002-2005, confirms that there are several other pathways for universities to contribute to local development beyond university patenting and university spinoffs (Lester 2005).

Next to the contribution of academic research to creating new markets (through patenting and spin-offs, academic research may be important to help transform existing industries, - improving the abilities of the existing network of local firms to *take up* new knowledge, and to *apply* this knowledge productively; academic research can help to adapt knowledge originating elsewhere to local conditions, to integrate previously separate areas of technological activity and to unlock and redirect knowledge that is already present in the region but not being put to productive use.

For cases of upgrading, bachelors and masters-level engineering graduates equipped with knowledge of the industry's practices and problems obtained from classes, practical theses, and internships are of greater value than PhDs. Arrangements are more likely to center on long-term relationships between the university and established firms, rather than on spin-off formation.

These findings cast further doubt on the utility of a one-size-fits-all approach to economic development that so many governments have been pursuing, with its focus on academic patenting, licensing, and startups. It calls for a broader view of the role of academic research

6. POLICIES TO ENHANCE ACADEMIC RESEARCH TO INNOVATION

Since the eighties a number of industrialized countries have implemented or considered policies to strengthen "linkages" between universities and public research organisations and industry, in order to enhance the contributions of academic research to innovation and economic performance (Cohen and Noll, 1994). Most of these initiatives share the premise that universities support innovation in industry primarily through the production of "deliverables" for commercialization (e.g., patented discoveries), despite the modest support for this premise in the research discussed above.

This section discusses a few of the most frequently used policy instruments for improving the contribution of academic research to (local) innovation and growth : IP ownership regulation (Baye-Dole type of regulations), support for industry-science collaborative research and support for institutional tech transfer building (Technology Transfer Offices, Science Parks and Incubators). It tries to assess the effectiveness of policy interventions to stimulate the contribution of academic research to innovation.

6.1. *INTELLECTUAL PROPERTY RIGHTS ; BAYH-DOLE;*

In the United States a significant milestone in the policy to promote the transfer of university-developed technology to industry was the passage of the federal Bayh-Dole Act and Stevenson-Wydler Act in the U.S. These regulations – which gave the universities the right to obtain intellectual property rights (IPR) from federally funded research (Nelson 2001, Mowery et al, 2001) – correlated with the adoption and the further development of IPR-related procedures and policies at universities (Branscomb et al. 1999; Clark, 1998; Van Looy et al., 2003). However, the causal impact of Bayh-Dole on the rise in "third mission" activities at universities remains empirically not yet established and controversial in the economic literature. For instance, Mowery et al (2005) warn for a misreading of the empirical evidence on the importance of intellectual property rights in facilitating the "transfer" and commercialization of university inventions. "Inasmuch as patenting and licensing are rated by industrial R&D managers as relatively unimportant for technology transfer in most fields, emulation of the Bayh-Dole Act is insufficient and perhaps even unnecessary to stimulate higher levels of university-industry interaction and technology transfer. Instead, reforms to enhance inter-institutional competition and autonomy within national university systems, as well as support for the external institutional contributors to new firm formation and technology commercialization, appear to be more important"

6.2. *TECHNOLOGY TRANSFER OFFICES*

Again following the rise of dedicated technology transfer offices at US universities, many European universities followed suit by setting up their own TTOs, in a number of countries with the support of public subsidies.

Nevertheless, the evidence even for the US shows that most of the TTOs fail to break even, lacking a sufficiently large deal flow (Astebro & Bazzanini (2011). Benchmarking within the EU specialized technology transfer offices there is no clear evidence on the effectiveness of these intermediaries and their role in improving industry science links (Polt, 2001). Most of the critical success factors for industry science links (such as appropriate incentive schemes and institutional settings, the level and orientation of R&D activities at both industry and science, legislation) cannot be shaped by the intermediaries themselves. They therefore often will fail to foster transfers if there exists other barriers to interaction. In the EU, most intermediary organizations are rather small and are therefore often below the necessary critical mass to be effective (Polt, 2001). There is also a danger that they will focus too much on the classic technology transfer (ie licensing and spin-offs), particularly if their mandate is to maximize the revenues to the university from technology transfer activities.

6.3. *Regional clusters; Science parks*

In many industrialized countries, efforts to increase the national economic returns from public investments in university research have attempted to stimulate the creation of "regional clusters" of innovative firms around universities. These undertakings seek to stimulate regional economic development and agglomeration via facilitating the creation of "spin-off" firms to commercialize university technologies (OECD, 2003).These policy initiatives are motivated by the high-technology regional clusters in the United States. Again, national and local governments in Europe have attempted to stimulate the formation of such clusters via funding for "science parks" .

Despite the widespread interest in science parks, there is little evidence that supports the argument that the presence of universities somehow "causes" the development of regional high-technology agglomerations. And even less evidence supports the argument that regional or innovation policies of governments are effective in creating these agglomerations. The U.S. experience suggests that the emergence of such agglomerations is a matter of contingency, path-dependence, and (most importantly) the presence of other supporting policies (intentional or otherwise) that may have little to do with university research or the encouragement of university-industry linkages.

6.4. *Industry Science R&D collaboration*

Financial support for collaborative research receives the largest portion of public money for promoting industry science links and is still gaining in importance in most countries. The EU framework programmes for research and technology development also follow this line of support and represent major additional funding for collaborative research. Likewise in the US, the

Advanced Technology Program (ATP) provides direct funding for pre-competitive generic cooperative research.

A more elaborate literature exists evaluating public support for R&D collaboration (for a review see eg Veugelers (2012)). . The predominant question analyzed by empirical literature is whether public subsidies crowd out private investment or whether they stimulate them. A few other studies also examine the impact of public subsidies on innovative performance and growth in recipient firms. Since neither the fact of applying, nor the fact of receiving a public subsidy can be viewed as random, the selection into such a process has to be taken into account (David et al (2000)). The more recent empirical literature, addressing this selection bias, rejects total crowding out. The vast majority of these studies find positive results for R&D intensity or patent activity. For a more comprehensive survey of most recent studies, see Cerulli (2010). These studies however do not single out R&D collaboration between industry and science versus other forms of R&D collaboration.

7. IMPLICATIONS FOR ISL POLICY MAKING

The evidence reviewed clearly shows the important role academic research can and does play in economies at wide and for their local economies in particular. The pathways through which this contribution materializes are manifold. The mode which is most often looked at by researchers, policy makers and the wider community and where most data are available is academic patenting. Evidence on academic patenting shows a growth over time, but at the same time it shows how concentrated the phenomenon is in few institutions, few technology areas and on few academic patents with high (licensing) value. The other most often looked at mode, the one of faculty spin-offs, has less well developed databases available, but also shows the same skewedness. The evidence also clearly shows the importance of geographic proximity for the effects of patenting and spin-offs to materialize. When looking at the evidence for Europe, there is a general lagging behind relative to the US on academic patenting and university spin-offs.

Patenting and licensing is only two of a number of pathways for the transfer of knowledge from universities to industry, and perhaps not even the best forms. Student & researchers' mobility from academe to industry is a critical mechanism to transfer knowledge from the university to industry, particularly when the knowledge to be transferred is hard to codify and is embodied in human capital as is the case for science-based knowledge. Although this is an area of great importance to the study of the innovation process, only recently research has started to attempt to trace researchers' intersectoral mobility.

Policy makers eager to boost the contribution of academic research to innovation and growth, all too often look for quick "success stories" trying to emulate often US success stories, like Silicon Valley, which have taken a long time to develop. Most policies lack a systemic, long term perspective needed to develop a triple helix eco-system.

Furthermore, the target of the policies is usually mostly narrowly focused on commercialization of university technologies, rather than more broader contribution to economic development. They all too often focus their target on patenting, licensing and spin-offs, and on emulating policy instruments which target these modes, like Bayh-Dole reforms and technology licensing offices. Although both modes receive most attention, they are however most probably among the least important gateways. Student spin-offs, graduate mobility and other more informal collaborative modes with industry are more effective to impact the innovative performance of industry.

There is no one-size-fits-all approach to stimulating the contribution of academic research to (regional) economic development that so many governments have been pursuing. The results from the still developing literature, calls for a broader view of the role of universities and public research organisations – as creators, receptors, and interpreters of innovation and ideas; as sources of human capital formation; and as key components of social infrastructure and social capital.

The policy initiatives that seek to stimulate university-industry linkages all suffer from a lack of a proper evaluation strategy prohibiting systematic evidence collection on the causal effects of the policies. To progress, policy makers should be more serious about evaluating their instruments and support more systematic data collection on the various pathways for universities' contribution. Overall, the most salient policy recommendations is that policy makers should be more "innovative" in their search for effective policy interventions, venturing beyond the classic spin-off and incubator programs. At the same time, they should be more serious about evaluating their new and existing instruments.

Although the evidence shows an important geographic proximity effect for industry science links to materialize and although most of the policy competence and funding is at the level of national and regional policy making, there is however also a policy agenda for international and European policy making to improve the contribution of academic research to innovation based growth. The EU level is a good platform to learn and diffuse best practices for local ISL policy making. This should also include a platform for data collection and analysis on ISLs, ISL policies and their effects in support of more evidence based ISL policy making. The EU level is also the level to improve the international connectedness of local industry science clusters. To this extent the pursuit of the European Research Area, creating an internal market for research with free mobility of research ideas, is an important lever to ensure this intra-EU connectedness. This includes also financial support through own EU funds in H2020 for cross border networking, industry science collaboration and mobility, particularly the EIT, and the Marie Curie Industrial Fellowship Programs. And beyond the intra-EU connecting, the EU should also play its role as stimulating global interconnectedness.

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Project Information

Welfare, Wealth and Work for Europe

A European research consortium is working on the analytical foundations for a socio-ecological transition

Abstract

Europe needs change. The financial crisis has exposed long-neglected deficiencies in the present growth path, most visibly in the areas of unemployment and public debt. At the same time, Europe has to cope with new challenges, ranging from globalisation and demographic shifts to new technologies and ecological challenges. Under the title of Welfare, Wealth and Work for Europe – WWWforEurope – a European research consortium is laying the analytical foundation for a new development strategy that will enable a socio-ecological transition to high levels of employment, social inclusion, gender equity and environmental sustainability. The four-year research project within the 7th Framework Programme funded by the European Commission was launched in April 2012. The consortium brings together researchers from 34 scientific institutions in 12 European countries and is coordinated by the Austrian Institute of Economic Research (WIFO). The project coordinator is Karl Aiginger, director of WIFO.

For details on WWWforEurope see: www.foreurope.eu

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