OPEN INNOVATION AND PUBLIC POLICY IN EUROPE

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Abstract

Industrial innovation processes are becoming more open. The large, vertically integrated R&D laboratory systems of the 20th century are giving way to more vertically disintegrated networks of innovation that connect numerous companies into ecosystems. Since innovation policy ultimately rests on the activities and initiatives of the private sector, it is vital that policy follows this evolution.

Previous innovation policies relied on large companies to act as the engines of innovation in the EU. While large companies remain quite relevant to innovation within the EU, they themselves report that their processes involve many more SMEs and other contributors outside their own walls. Therefore, innovation policy must also move outside the walls of these large companies and consider the roles of human capital, competition policy, financing, intellectual property, and public data in promoting an environment of open innovation.

In this report, we combine new research and analysis on open innovation with focused interviews of major participants in the European innovation system. The result is a series of recommendations for public policies that could, if implemented, improve the climate for open innovation to take place in the European Union – and thereby improve the competitiveness of the European economy overall. Taken together, these recommendations comprise an informal ‘charter’ for EU open innovation policy.
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Summary recommendations – a charter for open innovation policies in Europe

1. Education and human capital development

- Increase meritocracy in research funding within the EU.
- Support enhanced mobility during graduate training.

2. Financing open innovation: the funding chain

- Increase the pool of funds available for VC investment.
- Support the formation of university spin-offs to commercialise research discoveries.

3. Adopt a balanced approach to intellectual property

- Reduce transaction costs for intellectual property.
- Foster the growth of IP intermediaries.
- Rebalance university IP policies so broad diffusion of publicly funded research results is easier, rather than focusing on royalty income alone.

4. Promote cooperation and competition

- Shift support from national champions towards SMEs and start-up companies.
- Promote spin-offs from large companies and universities.
- Focus on innovation networks.

5. Expand open government

- Accelerate the publication of government data.
- Use open innovation processes in government procurement.
- Support private commercialisation of government funded technology.

1

Introduction: Open innovation and public policy

Open innovation is a rapidly spreading paradigm for business research, development and innovation. As outlined in Chesbrough 2003:

The distribution of knowledge has shifted away frowm the tall towers of central R&D facilities, toward variegated pools of knowledge distributed across the landscape. Companies can find vital knowledge in customers, suppliers, universities, national labs, consortia, consultants and even start-up firms. Companies must structure themselves to leverage these distributed pools.

Open innovation relies heavily upon the availability of external knowledge that companies assimilate and integrate into their businesses. Yet, the stock of available knowledge and its availability to firms cannot be taken for granted. This knowledge is the result of numerous, and often unconnected, public policies regarding science, technology, intellectual property (IP), and education within society. In this report, we will bring these background elements to the fore, and ask how governments can craft policies that support innovation in a world of widely dispersed knowledge, mobile workers, and venture capital (VC).

Many current public policy measures have their roots in the closed innovation era. They stem from a logic focused on developing large national or regional markets, protecting local companies, restricting foreign workers and students, and subsidising large local firms to keep them innovating. These prescriptions assume economic autarky, where national economies operate largely independently of one another.

Yet science and technology are nowadays widely diffused across the world. Most technologies are, nowadays, developed through a global network of technology partners. The number of technologies (even those that are thought to be crucial for national security) that can be developed and exploited within national borders is decreasing rapidly. Currently, no national or European government can reasonably hope to exclude a hostile government or interest group from having access to these technologies.

A similar reasoning applies to national procurement in EU member states for military and other technologies. Most national procurement regulations – especially those with military or national security applications – were born in a mindset of closed innovation. The increasing globalisation and rapid proliferation of open innovation implies that governmental agencies cannot effectively exclude others from accessing widely available technologies. The same erosion factors that have caused private firms to move away from the closed innovation mindset are also forcing innovation policies to change. In the United States, for instance, experiments along these lines came from the CIA when it contributed financial capital to start a venture firm, InQTel. This VC firm is chartered with finding innovative start-ups to commercialise important software and communication technologies. Importantly, InQTel does not need to follow any federal procurement regulation guidelines, and provides the CIA access to technologies that were previously difficult to access. In the UK, Qinetiq represented during its first years a similar initiative to set up commercial applications for military technologies. These initiatives make far better use of today's knowledge environment than policies based on a closed innovation logic.

Chesbrough 2003 examined several erosion factors that led to the decline of closed innovation. They included:

- increasing mobility of trained engineers and scientists
- increasing importance of venture capital
- greater dissemination of knowledge throughout the world
- increased quality of university research
- increased rivalry between companies in their product markets.

These factors help to enable a new division of labour in the funding, conduct, and focus of research and development (R&D) in innovation systems. This new division has caused businesses to shift the focus of their internal efforts from more basic research discoveries towards more external sources of knowledge, and has caused businesses to seek new uses for their knowledge more aggressively than in the recent past.
However, one important difference between the perspective of a firm and the perspective of a society is that a firm benefits from a single clear and coherent business model, while knowledge-intensive societies benefit from a multiplicity of business models competing to create value out of ideas. Venture capital has become an integral part of the innovation system in leading OECD countries, and combined with increased labour mobility, the result has been a larger role for small and medium sized enterprises (SMEs) in the industrial innovation systems of these countries. These SMEs offer society a variety of possible business models vying to create value out of knowledge.

Starting up new companies and growing them into global businesses is crucial for the economic growth of an economy. The US economy has spawned new global players in industries that were embryonic or non-existent 20 or 30 years ago; examples include Microsoft, Dell Computer, Cisco Systems, America Online, Genentech, Amgen, Millennium, eBay, Google, and Facebook.

Both the American and European economies have lost market share in manufacturing to the more efficient and responsive manufacturing systems of Japan and some other emerging Asian economies. The difference is that the European innovation system has been unable to copy the dynamism of the American innovation system over the last 20 years. Much of the American resurgence came from the ability of new firms to discover new industries, and of society's ability to redirect human, financial, and technological resources to these new firms and away from distressed industries. Moreover, this change went hand in hand with a more fundamental change in how innovation systems functioned. Internal R&D within large businesses became less important and gave way to external sourcing of technology as SMEs and universities became strong technology players.

If Europe wants to keep or improve its competitive position in the globalising knowledge economy in the next decade, then public policy has to develop some basic guidelines that are in line with the imperative of open innovation. We will develop some suggestions for these policy guidelines in the following sections. Firstly, we focus on education and human capital development and diffusion. We then analyse how the transition from closed to open innovation requires new funding systems. Thirdly, we tackle policy issues related to intellectual property. Fourthly, we look at how open innovation encourages policy makers to look at networks rather than individual firms – and to promote competition and rivalry in product markets. Finally, we look at some topics related to open government. We finalise this report by drawing some conclusions that can be considered a charter for open innovation policies in Europe.

2

Education, development and the diffusion of human capital

Open innovation can only thrive in a society when two key conditions of human capital are fulfilled: the educational system must systematically create highly qualified labour; and knowledge workers must be highly mobile. There is a general consensus (in Europe) that the government has to play a role in fostering the creation and diffusion of high quality knowledge within society. To realise this objective a society's educational system has to take a central role in innovation policymaking. Related to issues of creating a skilled workforce, are policies that facilitate the mobility of that workforce. Pensions, social security, healthcare, and other aspects of compensation are typically tied to employment, and this effectively constrains mobility. Making these benefits portable, or severing their tie to a specific employer, would enable workers to seek the best opportunities to use their skills.

2.1 Human capital creation

Top level research and technology development hinges on the availability of excellent scientists and researchers. Universities play a key role in educating new generations of researchers and scientists, and in generating new knowledge through research. Yet, a quick look at the worldwide ranking of EU universities compared to American universities in terms of publications and citation indices, Nobel prizes, valuable patents, and university spin-offs shows that the Americans do better in academic research. The relative position of Europe is also worsening as several non-Western countries rapidly upgrade their educational and knowledge infrastructures and quickly climb in the international rankings.

One reason: There is no transparency in the European educational system. It is not easy to compare universities in the same country, and international comparisons within Europe are much harder. It is crucial that European policy makers set up a ranking system for universities in Europe against which all institutions can be benchmarked (as the European Commission is currently considering.) Any metric is simplistic. But better rankings would offer students information about how much value they can expect for their money. As a result, good students would look for good universities, and so offer Europe much better researchers. When rigorous research assessments were introduced in the UK, university administrators began to think about their strengths and weaknesses. As a result, they either addressed their weaknesses or started differentiating their offerings from other universities by building on their strengths.

As well as educating new students and researchers as a key resource, universities and related research institutes also play an important role in advancing basic research. Only two decades ago, large industrial companies had enormous corporate R&D centres where research was oriented towards the mission of the company and each centre had greater scientific and technological capabilities than most universities. The majority of these central labs were dismantled – especially during the 1990s – because large companies were forced by shareholders to focus on short-term profits, or just plain survival. At the same time, the governments (especially in the US) were investing in research systems, national labs, and major universities. In this way, the incentives weakened for large companies to tackle (basic) research themselves, rather than working with major universities and, more generally, the innovation ecosystem existing in different countries. In consequence, as companies focused on applied sciences and the development and commercialisation of technologies, universities became the major (and maybe only) institutions driving basic science research. As a result, governments have to make investments in fundamental science – which, if managed appropriately, is a major source of new technological developments.

The success of the Defense Advanced Research Projects Agency (DARPA) in funding basic research in the US in information technologies is a demonstration of how government funding, directed to decentralised research institutions, can yield cumulatively important research outcomes.

During our interviews with leading R&D managers in major industrial companies in Western Europe, there was a surprising unanimity that research in Europe is not ‘in good shape’ because of institutional inhibitors. While there is great research in Europe, getting more of it hinges on top researchers working in top institutes. Large manufacturing companies are interested in accessing the fundamental research capabilities of top-performing universities and research labs, but not second-tier universities. Hence, what counts is the presence of world-leading research labs. Top researchers will work in universities and research institutes that can offer leading edge knowledge infrastructures, interesting connections or collaboration opportunities with other top researchers, and large, long-term projects (5-10 years depending on the technological field). The latter is necessary as it enables researchers to build a faculty that is large enough to cope with important scientific problems and there is enough time to move the scientific frontier through scientific publications.

Europe faces problems in generating sufficient top-level research that can compete with universities and research institutes on a global scale. Unlike agricultural funding, R&D budgets are still mostly a national matter; 93% to 95% of all public-sector research spending in Europe is funded nationally. Of course, the European Commission has launched a number of central initiatives such as the European Research Council (ERC); but budgets are limited in comparison with those of the US National Science Foundation (NSF), the National Institutes of Health (NIH), and a number of private American foundations. As a result, there is no pan-European competition between universities as in the US. What provides the drive at American universities to have the best researchers and labs? Every lab must be funded every four to five years through national competition. Permanent competition is the best way to match budgets to the best technology. To this end, the European Commission should convince member states to transfer more of their R&D budgets to the ERC, provided that the basis for resource allocation is meritocratic and not political.

The current system used in the rest of the EU's Seventh Framework Programme (FP-7) projects, is not really a contribution to pan-European competition between universities/research labs. The requirement in many FP-7 projects that research partners collaborate with many different universities and many different companies adds cost and slows the pace of work. Participants lose their competitive edge, or seek funding elsewhere where administrative procedures are quicker and grants are usually larger. In sum, research programmes should be made competitive on a pan-European scale and universities should collaborate only if it actually improves the proposition.

2.2. Knowledge diffusion

Diffusion of knowledge is as important as creation to spur innovation within society. Yet many European countries have long-standing policies that constrain the diffusion of knowledge from universities to industry. For example, university lecturers in many European countries are civil servants, prohibited from working with and for private companies while drawing a public salary. Consequently, universities cannot learn from management practices in industry. Graduate students in many of these same countries are effectively indentured servants of the lecturers they work for, and cannot seek out the best places to apply their cutting edge knowledge. Lack of mobility has other unintended side effects. When faculty members select their next research initiative, they do so in ignorance of the burning issues that need to be addressed in other areas, including industry. This ignorance multiplies when university staff review the research proposals of their peers to allocate funding, or oversee the training of their students. Research by Van Looy et al. (2004) demonstrates that researchers who work closely with companies doing applied research achieve higher quality rankings for their fundamental research than peers who do not collaborate with industry. Therefore, contrary to the traditional thinking, academics do not face a trade-off between collaborating with industry and doing fundamental research. Both activities are highly complementary.

Diffusion of knowledge between universities and business would be dramatically improved if academics could temporarily be employed in private companies, and vice versa. But at present, if an academic researcher leaves to work in a company and later returns, he or she cannot be promoted because they will not have published any papers during their absence from the university. A similar pattern emerges when managers take an academic post. However, there is some flexibility in this area. Some companies are sending managers to academia as part of their career development. This requires that the courses be adapted for the transition and that industry has a model of career development that deliberately advances the capabilities of managers.

There are other barriers to mobility of knowledge workers. Pensions, social security, healthcare, and other aspects of compensation are typically tied to employment. Making these benefits portable would enable workers to seek out the best opportunities to use their skills. Moreover, social legislation in Europe is largely determined by national authorities, which implies that labour movement between member states involves plenty of complicated paperwork. Further, there is an urgent need to develop a European economic immigration policy that lowers immigration barriers for a highly qualified labour force. This has proven to be a useful strategy for the US, where a continuous inflow of highly qualified labour has supported American scientific, technological, and economic strength for decades. The EU could also learn from mobility policy in China, which has adopted a number of initiatives to encourage Chinese citizens who were working abroad to return to China later in their careers. These so-called 'sea turtles' bring a wealth of international business and scientific expertise with them, and help to rejuvenate the culture of the organisations in China that they join upon their return. However, this policy can only work when the research conditions in Europe are similar (or better) than those abroad. Top researchers will not return to their home country when the conditions for research are worse than those abroad. Finally, another area for EU reform is policy toward retirees. Yet with the continued progress in healthcare, longer life expectancies, and an aging population in most EU countries, there is too much valuable knowledge residing in the minds of retirees to be neglected. The time has come to tap into this source of 'seasoned' knowledge – whether it is through coaching, mentoring, teaching, project work, or other less-than-full-time employment.

In sum, labour mobility eases the tacit knowledge flow between organisations. Mobility also induces networking between organisations and knowledge spillovers (Cohen and Fields 2000). Therefore, the productivity of a skilled workforce is determined by the quality of the skills as well as the mobility of the workforce. A fast flow of ideas generates more value than ideas that are locked into the boundaries of a single company.

3

Financing open innovation: The funding chain

The European Commission must consider new ways to channel financial resources to promising new ideas and business models. While education produces knowledge, it requires financial capital to take those ideas to market. Many traditional innovation policies erroneously provide direct incentives to companies (usually large companies) to undertake R&D. Such incentives take no account of the erosion factors confronting the recipients of these incentives, and under-serve small and medium sized enterprises (see Chesbrough 2003, 2006). While companies will surely pocket incentives for research, their willingness to undertake additional research internally is offset by the problems of diffusion, of being able to profit from the technology they develop. As these problems grow, more incentives will be required to stimulate the same level of R&D within the firms.

Thus, direct incentives for R&D are ill-advised; they require public managers to make judgments about the prospects and merits of innovation at private companies. These judgments are inherently subjective, and are best left to private equity suppliers, who compete to supply capital to promising opportunities. Competition enables a diversity of innovation approaches to be funded, and elicits greater investment in governance by the suppliers of this capital. These owners will also be able to adapt much more readily to new information than public servants.

If highly innovative companies drive economic growth, then the EU focus should be on the economic world and the funding chain. The funding chain conceptualises the need to have appropriate types of financing for all stages – from research to the establishment and growth of a new venture. In each stage, the type of funding has to change and different funding partners will be involved. Compared to the traditional innovation policy guidelines in Europe, more attention should be paid to the appropriate funding of the commercialisation of new ideas into real business opportunities. A smoothly working VC market is a crucial element in the funding chain.

The size of the venture capital market in Europe is about one quarter that in the US. The role of VCs is to finance ventures for a number of years. These ventures then need to grow and become competitive. Accordingly, in areas where technology cycles are long (especially in biopharmaceuticals, and aerospace) a venture cannot grow into a large company in just five years; 10 or 20 are needed. If there is no strong stock market, as at present, then VCs often have to sell the company prematurely to established companies. Acquisition by large companies is fine if economic reasons (such as complementary assets and global reach) drive it. But acquisitions that occur because VCs have run out of money lead to suboptimal solutions from a welfare point of view. Moreover, when the main acquirers are American companies in biotech for instance, the result limits economic growth in Europe. It is thus a matter of encouraging more investments into these start-up firms.

Unfortunately, new regulations for banks and insurance companies are reducing their investments in the stock market; and this damages new ventures. Europe needs proactive reform. Five to seven percent of savings could, for instance, be channelled into rapidly growing and innovative companies. Europe has among the highest saving rates in the world, but these funds are invested in low risk and under-productive areas. There is plenty for corporate and government bonds, but very little for growing companies. While fiscal policy is not directly in its legal authority to control, the European Commission could use its coordinating and exhortatory powers to have member-states provide new incentives for investment in R&D-based ventures. To do so, it could clearly define the target companies. They should be independent, not subsidiaries of larger companies. They should be spending 15% to 20% of their overall budgets on R&D. They should not be more than 10 years old.

With the right investments, European high-tech ventures could create more economic growth in Europe.

4

Adopt a balanced approach to intellectual property

A government that wants to promote open innovation should provide private firms with enough protection to induce them to invest in creating new IP. At the same time, a government has an over-riding interest to ensure that technology is commercialised in as many ways as possible and disseminated widely throughout society. Policy makers should remain concerned with this apparent trade-off between incentives to innovate and ease of diffusion. But recent shifts in the R&D strategies of private firms may suggest that markets for technology can play a more important role in promoting diffusion than in the past (Arora and Gambardella, 2010). As companies look to make greater use of their IP outside of their own businesses, the supply of knowledge available in the market should increase. Thus, governments should clarify the ownership of IP, and provide the institutional and legal support for its purchase and exchange.

However, this clarification of IP ownership should be limited in scope. In open innovation, firms invest in R&D to extend their current business models, and occasionally to search for new models. These firms cannot and do not make every conceivable use of their ideas within their own walls. Innovation policies for the protection of ideas must accept the limits of what any single firm can do with its ideas and technologies, and promote the recombination and reuse of the available knowledge in other companies. Direct expropriation of such ideas without compensation would be a terrible policy. But granting wide-ranging ownership rights to ideas that are not strictly controlled in their novelty, usefulness, and non-trivial nature is equally problematic. The first realisation of an idea is often incomplete. Granting broad ownership rights could strangle the follow-on innovative work that enhances the value of that idea. For similar reasons, granting ownership rights to ideas for very long periods of time can be problematic. A balance must be struck between invention and diffusion. And that balance is disturbed by several factors in Europe, from the cost of patent application to the local nature of the IP market.

4.1 Open innovation fostered by high quality patents

The European Patent Office (EPO) has the reputation of high quality, according to our interviewees. When the EPO grants a patent, it signals some embedded value when the inventor wants to license the technology, or when the start-up receiving the patent seeks external financing. The EPO approach also prevents companies becoming easily blocked (in developing or producing new products) by poor quality patent families owned by other companies or non-practicing entities (e.g. patent trolls) as was the case in the US until recently (the strategy of the US Patent and Trademark Office has changed in the last few years in this regard).

Clear legal protection of high quality patents is not in contradiction with an open innovation policy that strives to provide adequate incentives to undertake research and diffuse these discoveries widely. In fact, open innovation would literally be impossible without IP protection, as firms would resist sharing their ideas for fear competitors would steal them. Indeed, it can be argued that open innovation increases the need for robust IP protection. In developing a new medicine, for instance, the separate tasks of research, development, trials and marketing may be conducted by different companies or groups – yet the overall financial return still needs to cover the costs of each step plus produce profit margins for each participant. So, there is a need to generate the same or greater returns to sustain all the parts of the R&D ecosystem – and this depends in part on robust IP. Within an open innovation framework, IP is not a fence preventing others from making use of a protected technology; but rather a bridge to collaboration with other firms and organisations. Indeed, leading scholars say a solid patent system provides opportunities for firms to overcome Arrow's (1962) 'disclosure problem'. However, there are still significant transaction costs in transferring technologies. Selling technologies in the marketplace is not fully leveraged and according to Gambardella, Giuri and Luzzi (2007) the market for technology could be 70% larger if transaction costs could be further reduced. The high percentage of unused but patented inventions could provide a ready supply of technology to the market if these costs could be addressed.

4.2 Open innovation hampered by the high costs of the European IP system

Europe has been working for almost half a century on its IP system (Van Pottelsberghe de la Potterie, 2010). However, the current system remains overly complex, opaque, and unpredictable; and it constitutes a heavy financial burden for small companies or start-up companies (Veugelers, 2009).

The European IP system is the most expensive and complex in the world due to its high level of fragmentation and translation requirements. Moreover, once a patent is granted by the EPO it must be enforced (i.e. translated, validated, and renewed on a yearly basis) by the national jurisdictions of the countries in which the patent is applied. The London Agreement, which intends to reduce the translation requirements for patents when they are validated at national patent offices in 15 out of 34 states, has led to a reduction in the cost of patenting by 20% to 30% (Van Pottelsberghe de la Potterie & Mejer, 2010). Despite these savings, the relative cost of a European patent validated in six countries is still five times higher than in the US. These costs have a major impact on the number of potential patents that are not submitted (or withdrawn). The difference in price between the US and

Europe partly explains why the USPTO attracts four times as many patent filings as the EPO (Van Pottelsberghe de la Potterie & Francois, 2009).

IP is increasingly embodied in business strategies; and an efficient IP system is crucial in the development of more R&D collaboration and technology transfer. A bold shift to a single European patent would drastically reduce the costs and complexity of the current system. This needs to be matched to a centralised litigation process via a single court. It is fundamental that this Pan-European Patent Court (known as the European and EU Patent Court or EEUPC) has clear rules of procedure and is run by a highly qualified group of IP judges. Otherwise, the perspective of a single patent being invalidated in any one of 27 member states after a trial of variable quality would be a significant step backwards.

There is room for improvement in other areas. The EPO is currently working to reduce the time to grant a patent (currently 49 months) which compares unfavourably to the JPO (31 months) and the USPTO (27 months). And Van Pottelsberghe (2010) suggests a "50% reduction in entry fees for a well-defined group of young innovative companies up to the sixth year (the average duration of the examination period). A pay-back process (of the 50% reduction) could be scheduled for companies that keep their patents enforced for more than six years." Generally, open innovation should encourages European policy makers to invigorate the European patent system. Therefore, it is interesting to notice that the EU in the last 12 months has made progress on a unified patent system.

4.3 Aligning incentives of researchers and industry

Researchers at universities and other public labs carrying out research for companies always face tension between their desire to publish early and the requirements of the contracting companies to keep inventions secret until a patent is filed. Currently, a patent application will be rejected in Europe if the invention has become publicly available before the application was filed. This includes selling the invention, giving a lecture about it, showing it to an investor without a non-disclosure agreement (NDA), or publishing it in a scientific journal. The US, by contrast, has a one-year grace period. This means that the inventor there can freely publish without losing patent rights. The European patent system would benefit from the introduction of a similar grace period.

In general, IP discussions between research institutes (or universities) and companies can troublesome if:

- Academic centres over-value their IP and over-estimate the odds of making a profit, leading to elevated expectations of royalty payments that make projects untenable; or
- Academic centres attempt to patent their work but do so badly, leading either to a lack of protection in key global markets or – worse still – creating 'prior art' that invalidates patents on more useful developments of the same technology.
- These collaboration problems in research institutes or universities require professional IP management.

4.4 Activating unused IP in large companies

Multinationals have vast portfolios of patents. To protect their inventions a company such as Philips files, via its Intellectual Property and Standards organisation (IP&S), an average of 1600 patent applications annually. It owned 55,000 patents in 2009, and employed 500 IP professionals and support staff worldwide. However, about 85% of all patents of large companies are never used in new products, or are used to deter potential competitors. From a public policy point of view, unused patents represent a large untapped source of knowledge that could create new companies and economic growth if there were an efficient way to 'activate' these unused patents in other companies.

To be sure, major companies with large patent portfolios can monetise unused technologies. Patents are frequently used as tickets in cross-licensing negotiations (mostly) with other large companies. However, licensing technologies from large companies to small firms, or creating new ventures based on the IP of large companies, is not common practice everywhere. Licensing out technology or spinning off ventures requires time and energy. And the return is likely to be small, as SMEs and start-ups generate insufficient revenues to seriously interest a large company that wants to monetise its unused IP. There are exceptions, however. Microsoft, for instance, has established a unit called IP Ventures, which partners with start-ups, venture capitalists, and government agencies to take inventions created by Microsoft Research and put them in the hands of entrepreneurs and small companies. Microsoft is working closely with government economic development agencies such as Enterprise Ireland and the Finnish National Fund for Research and Development (Sitra) to transfer technology and spur the growth of small businesses (Gutierrez, 2008). Licensing out IP is also an increasing trend in pharmaceutical and chemical companies.

4.5 Large scale technology collaboration and IP agreements

IP transfers can take more complex forms than bilateral agreements between two organisations. The growing complexity of technologies is forcing companies to team up with various types of partners in broad consortia. Examples include the IIAP programmes of IMEC, CTMM, and IMI. In IMEC's Industrial Affiliation Programmes, IMEC invites partners to collaborate on precompetitive research on nano-electronics and uses the so-called fingerprint IP-model to deal with background IP in collaborative research and IP-ownership and the use of jointly developed technologies (Odusanya et al. 2009; Vanhelleputte and Reid, 2004). The Centre for Translational Molecular Medicine (CTMM) develops medical technologies that enable the design of new and 'personalised' treatments for the main causes of mortality and diminished quality of life (cancer and cardiovascular diseases and, to a lesser extent, neurodegenerative and infectious/autoimmune diseases). It is a public-private consortium that comprises universities, medical centres, medical technology firms, and chemical and pharmaceutical companies. CTMM is using a similar IP model as IMEC to distribute the benefits of the joint research among the participants (including those that cannot generate patents, such as hospitals).

The Innovative Medicines Initiative (IMI) is a partnership between the European Union and the European Federation of Pharmaceutical Industries and Associations (EFPIA). The aim of IMI is to support the faster discovery and development of better medicines for patients and to enhance Europe's competitiveness by ensuring that its biopharmaceutical sector remains dynamic. Participants in the IMI (research institutes, SMEs, and large pharmaceutical companies) generate IP which is owned by the participant(s) who generated it (or when no individual participant can be identified the IP is jointly owned by those who have carried out the work). Participants have access to the knowledge developed in IMI before completion of the project and they have access to IP for research purposes after the project. Beyond the research, participants may use, sublicense, or commercialise the foreground they own.

These complex forms of joint research require careful thinking about ownership and the use of commonly developed IP. The pressure on universities to generate revenues from their research can exacerbate problems in some IP negotiations. In the IMI, for example, competing pharmaceutical companies agree that results of pre-competitive research can be made freely available, but some university technology transfer offices want ownership over any IP generated by their work. The idea of academic centres being worried about appropriating returns, while industry at times accepts free access, runs counter to many public expectations; but it represents an important trend. These complex forms of multi-partner collaboration are shaping the future of European research; therefore, it is desirable that policy makers help in encouraging collaborative IP rules based on good practices. The current FP7 IP rules are not adapted to these complex forms of collaboration.

4.6 Opening broader channels of collaboration

Open business models have proven very effective in different parts of industry. In many cases, firms with considerable IP assets have decided to open specific parts of their IP portfolio to communities of practitioners or users. For example, IBM's IP Collaborative Innovation initiative pledged 500 patents to Open Source communities, launched an Open Innovation Network, and established an American university summit for open collaboration. Similarly, Sony and Nokia have decided to share a portion of their patent portfolios to stimulate innovation in green technologies. Another successful collaboration is the GreenXchange, a breakthrough concept for sharing IP among companies that are working on sustainability issues in the footwear sector. And Microsoft is increasingly cooperating with major Linux software providers to enhance the interoperability of Windows and Linux through joint technology development. As customers want to use both systems to work together seamlessly and efficiently, Microsoft and Novell created an IP bridge between the worlds of Open Source and proprietary software.

4.7 Promoting intermediaries to facilitate the diffusion of knowledge

Recently a new form of third party – innovation intermediary or 'innomediary' - has emerged around the world. NineSigma, InnoCentive, Yet2.com, YourEncore are a few. These intermediaries facilitate collaboration across technology markets by providing innovation platforms that link companies with potential problem solvers, and facilitate the diffusion of knowledge or technologies.

There are significant transaction costs in transferring technologies. Selling technologies in the marketplace is not fully leveraged and according to (Gambardella, Giuri & Luzzi; 2007) the market for technology could be 70% larger if transaction costs were reduced. These new intermediaries are shaping the market for technologies, and they help make the market for knowledge and IP more transparent; EU policy makers should take note. The intermediaries have been mainly focused on major companies as clients, but there is enormous potential for using their expertise to solve problems for universities, research labs, and SMEs. These cannot currently afford these innovation intermediaries; and so policy makers could analyse how costs could be lowered to an acceptable level for these groups.

4.8 Extending the IP scope beyond patents

Patents are only one form of IP protection and are very good for protecting IP that is related to a broad range of technologies. For instance, in the pharmaceutical industry patents are used for protecting the molecular structures of medicines. But the industry has always sold more than that; value is also determined by knowledge about how these medicines can and should be used. The knowledge is generated in clinical trials, which now account for around 60% of the R&D costs (up from 50% a decade or so ago). Moreover, drug manufacturers are being asked for ever-greater amounts of data by regulators and reimbursement agencies, and this data is costly to produce. Thus, Data Exclusivity (DE) is another important form of IP protection for pharmaceutical companies; it is generating incentives for companies to collect data (particularly clinical data) on a medicine to investigate its value in treating new indications. Hence, it is important in the context of open innovation that policy makers pay attention to the increasing heterogeneity of data and information.

Similarly, trademarks, copyrights, trade-secrets and industrial design rights are important in the discussion of an open innovation policy. The emergence of the internet is changing and will continue to change the business models that are used in many service industries (Chesbrough, 2011). Policy measures can have a considerable impact on the speed and direction of these changes – as we have seen in the music industry – but the European Commission could play a major role in proactively ensuring that IP regulation supports the conditions for business model changes in several services industries that rely on these types of IP protection.

5

Promoting cooperation and competition

Open innovation can only prosper when policy makers avoid monopoly and promote rivalry within the economy. If market competition is strong within an industry, firms will be motivated to find ways to exploit their ideas as fully as possible. If market leaders are in a position to enforce monopolies in their markets, then the open innovation process can easily break down. Monopolistic firms could attempt to hoard their ideas and technologies and exclude them from rivals. In the process, other ways of using these ideas in society could also be thwarted. In an open innovation era, a narrow focus of policy on large companies is no longer effective. Policy makers must focus on the innovation ecosystem and pay more attention to start-ups and SMEs. That focus requires greater attention, as well, on the regulatory barriers and problems of coordination which can slow the uptake of new technologies – a problem that the European Commission has noted in its recent Innovation Union strategy.

5.1 The locus of innovation is in the network

Nowadays, knowledge is abundant and the technology landscape is scattered. Therefore, policy makers have to shift their support from single firms to the innovation ecosystem that is creating and commercialising technologies. They have to look at the different nodes in the 'food chain,' from science to commercially viable product introductions. Innovation policy can play a crucial role in stimulating innovation systems in which universities, labs, start-ups, and large companies jointly create new market opportunities. The locus of innovation is no longer in the firm but in the network (Powell et al, 1997). An analogous shift in policy making should redirect the policy focus from single large companies towards networks or ecosystems in which innovation partners jointly create new business opportunities.

Pharmaceutical companies, for instance, experience quick changes in their innovation process. Industry officials say their R&D productivity has declined in recent years. Attrition rates in development have remained high. At the same time, spending has increased to cover the rising demands for clinical data from regulators and payers. As a response to declining research productivity, these companies have adapted their R&D organisations. More and more stages of the R&D process are undertaken through collaboration or out-sourcing. At the research level, companies deploy many different models for creating effective collaborations: contractual research agreements for specific research tasks; bilateral agreements with individual universities and research groups; collaborations with other companies on areas of pre-competitive research; bi-lateral agreements with other companies to progress specific research areas or specific high-cost development projects. Some companies have a venture fund and external research experts dedicated to finding partners and generating new deals and collaborations.

5.2 SME formation and growth

This shift to the network also implies that innovation public policy should seek to cultivate and strengthen small and medium sized firms. Their vitality will infuse a greater dynamism into the economy, as those companies that survive will embody new combinations of knowledge, and new business models to commercialise that knowledge. These companies will also spur greater innovation from larger companies. They provide large companies with demonstrations of the commercial viability of new approaches to commercialising ideas, and their success confronts incumbent firms with hard facts that they ignore at their peril.

Incumbents will respond to the demonstrated success of new firms with new combinations of knowledge far more rapidly than they will respond to any direct government programme targeted to support them. Start-ups often have new technologies or are highly creative in developing new business models to commercialise knowledge; therefore, they are also great sources for large companies to in-source new technologies and business models for commercialising technologies.

To spur open innovation, policy makers should facilitate the creation of start-ups and encourage entrepreneurship in the European economy. They must also spur cooperation between SMEs and large companies to discover knowledge about the functioning of technologies and enact new technological ecosystems as system integrators. Finally, a new breed of managers is needed in large companies with the skills to set up new ventures such as spin-offs based on unused but patented technologies.

European VC-backed ventures should be able to grow into fully developed businesses that can compete on an international or global scale. There should be different financing schemes all the way from seed to late stage; otherwise too many European high-tech ventures will be acquired by large American and Chinese companies. If there is sufficient money available in the VCF market then start-ups can develop new manufacturing and distribution assets. The composition of the boards also plays a role in stimulating high-tech start-ups. These companies need directors who know the industry very well. In Europe, executives from large companies do not usually want to 'waste their time' being board members in small companies. However, large companies that do encourage their directors to sit on small boards (such as Microsoft, Novartis, GE, BP, Pfizer and DSM) generate two effects. Firstly, board membership gives early access to new technologies with considerable business opportunities. Secondly, the directors bring their experience to the start-up company.

Let's take, for instance, the Novartis venture fund. When Novartis invests in start-ups it shares its views on the industry with the start-up, and brings a great deal of expertise from the pharmaceutical industry. This is of enormous value for the start-up because, while a small company may have vision and new technologies, it will probably also lack many managerial skills necessary to avoid obvious mistakes. A good board significantly increases the economic viability of start-ups. Governments should incentivise large companies to encourage their directors to become board members in start-ups.

The way in which VCs are managed is also very important. In America, VCFs are mostly managed by former entrepreneurs and former executives of large technology companies who have become investors. This approach is the right way to do it. Growing new ventures is not about how to analyse profit and loss accounts – investors have to know the field, the technology, and understand the value proposition that will create competitive advantage for the venture. Too often in Europe venture capital firms are headed by people with a financial background, and no experience in industry or academia. Consequently, there is a high risk of making mistakes or making overly conservative decisions – creating followers instead of leading ventures. Therefore, it would be good in Europe to stimulate the formation of independent VCs that are led by people with a strong research, clinical, or industrial background. The EC could, for example, launch a programme through the European Investment Fund to stimulate the creation of new funds – provided there is a new team with a broad, international background.

A final note: more than funding is required if SMEs are going to be able routinely to launch major medicines again. Regulatory and market reforms are also essential (these would benefit big and small companies). Growing needs for deep scientific knowledge, increasing sensitivities to risk (and liability), ever-greater demands for data from regulators and payers, and the need to globalise revenues to generate ROI have made launching medicines a difficult game for all, large or small. The Commission's attention to these issues – for instance, in its proposed European Innovation Partnership on healthy ageing – is needed.

6

Expanding open government

Governments are the owners of the largest databases in the world with unprecedented possibilities for new and functional technologies and information for commercial and other uses. To establish a transparent, accountable, and innovative management system, governments are transforming their public services into more open, accessible, and collaborative structures. However, the most powerful information sources are nowadays not in the hands of the governments, but in hands of large corporations like Google (De Jong et al., 2008). The rapidly growing global distribution of information via internet is an important driver of open innovation. But the uncontrolled growth of online knowledge repositories can also hamper open innovation. Easy access to these repositories is considered critical to open innovation. Thus governments have to be vigilant and monitor the evolution of online repositories to ensure that private companies do not have a monopoly over information that is useful for society.

6.1 Open government and open data

Recently, there have been several 'open data' initiatives around the world promoting interactive sharing of information between the government and the public. Open data refers to a practice of making data freely available online in a standard and re-useable format for everyone to use (Fung and Weil, 2010). City halls collect extensive data about residents and the city. 'Data' in this case refers to everything from electoral statistics to the location of schools or parking lots.

As governments realise the benefits, open data has emerged as an essential movement across the world. Many local and national governments have created their own 'data portals' to list data (such as 'data.gov.uk' in the United Kingdom). These open data portals allow citizens to access all public information obtained during public affairs management in standard and re-useable formats. Thus open data is the key foundation of an open government initiative. The social benefits of open government vary from citizen engagement to increased transparency and accountability, or enhanced communication channels. For instance, citizens gain greater insights into how their taxes are spent. Real time availability of information also increases the potential to create extra services (Fung and Weil, 2010).

Open government also supports public sector innovation through diminishing bureaucracy and friction in data exchange and demolishing competitive advantages gained by proprietary access to data. Innovation is most likely to occur when data is available online in open, structured, computer-friendly formats for anyone to download (Robinson, et al, 2009). Excellent examples include the USPTO and EPO databases about patents that are applied for and issued in the US and Europe respectively. These databases have been used by thousands of researchers and have advanced our understanding of the role of innovation in creating competitive advantage at the firm level and wealth creation at the macro-economic level.

To foster innovation, government entities often use 'contests' to encourage citizens to collaborate. 'Apps' contests are common (such as 'Apps for Democracy') to build web applications and services with open data. US government agencies have also launched challenges such as Challenge.gov or NASA Centennial Challenges Program for citizens to provide and share their solutions and innovations with the government. Other platforms for communication include 'Blue Button,' an online health portal where people can download their health information securely and privately; or 'Federal Register 2.0,' an attempt to organise articles into news sections for readers to browse by topic and by government agency, and which enables citizens to submit comments on regulatory actions.

Since government data is important for both government and citizens, a clear policy on how governments should open and distribute their data is required. Open data projects use the following principles: data should be complete, original, available online (such as in HTTP format) or in structured formats such as XML, uniquely addressable, machine readable, license-free without limitation for anyone or anything, and offered in a timely manner (Robinson et al., 2009). Furthermore, governments should develop a central online portal so that data can be browsed and downloaded by citizens. There should also be a commitment by the government to regularly update data.

But there remains a number of areas where details must be worked out. Much government data is dispersed and some is still not fully disclosed. Deciding which data should be published is an important decision. Today many politicians strongly believe in the public's right to access all information – even information that is directly related to national security and privacy issues. To accomplish this, there are certain guidelines for how to ensure disclosure while protecting national security and individual privacy (Swartz, 2010). Thus governments should strike a balance between the requirements of openness and considerations calling for non-disclosure.

6.2 Extending the idea of open government

The idea of open government can be extended to areas where the government is a monopolist. Public procurement drives demand for innovative goods and services – as analysed previously in the Aho report (2006). Examples where public purchases play a crucial role in driving top technology are defence, aerospace, road and railway infrastructure, and specific ICT applications. These purchases of innovative products encourage suppliers to generate top technologies that also represent interesting but untapped sources of innovations in commercial applications. There are numerous examples of how military technologies can successfully lead to commercial applications. The same holds for aerospace technology, which even leads to new products in low-tech industries – see, for example, Quilts of Denmark's functional quilts, based partly on NASA technology (Vanhaverbeke and Bakici, 2010).

However, the commercialisation of technologies developed in these industries does not come automatically. On the contrary, companies that develop high-tech products for governments usually have priorities and capabilities other than those required to develop commercial products. Usually, other types of organisations handle commercialisation. A few examples include MILCOM Technologies (now part of Arsenal Venture Partners) and (the early) Qinetic. Both organisations search for interesting technologies that have been developed originally for military purposes and turn them into commercial applications through licensing deals or new ventures.

Starting with the 1958 National Aeronautics and Space Act, some US federal agencies such as NASA have been required to facilitate the transfer of technology to other sectors. NASA has established 1700 spin-offs and has organised itself to actively pursue market opportunities. The transfer, application, and commercialisation of NASA-funded technology occurs in many ways – knowledge sharing, technical assistance, intellectual property licensing, cooperative research and technology projects, and other forms of partnership (such as the NASA Open Government Plan). Similarly, the Space Foundation is a national non-profit organisation in the US that is certifying products that originate from space-related technology or use space-derived resources for consumer benefit. Governments can further stimulate the commercialisation of these technologies through funding. In the US, the Small Business Innovative Research (SBIR) programme distributes $2.5 billion per year in R&D grants across 11 federal agencies, including $1.2 billion distributed by the Department of Defense. Companies whose products have high transition potential are eligible for 'commercialisation' funding.

In conclusion, to encourage collaboration and innovation, the old top-down model of government data management must be changed into a networked model. The scope of open data should also be expanded. Publishing data in bulk must be a government's first priority as an information provider. By publishing data in a form that is free, open, and reusable, governments will empower many innovative ideas. However, the provision of data alone will not lead to the goals of open government. Governments need to design effective legislation and policies to support this collaborative approach with citizens. Data must be processed and an open government ecosystem should be created. Open government, if implemented effectively, can improve the accountability of government, as well as boosting innovation in and beyond the public sector.

Public policy makers can also play a role in encouraging the commercialisation of technologies that have been developed in industries where the government is the sole customer. Examples include the defence industry, aerospace, road and railway infrastructure, and national security. Many of these technologies have the potential to be commercialised; but this does not happen automatically. The development of commercial applications for these technologies requires the help of specific organisations that are specialised in detecting and developing commercial applications. Governments should look at good practices and accelerate the search for commercial applications for these captive technologies.

7

Summary of policy recommendations

Many past and present innovation policies stem from a logic that is reminiscent of a closed innovation mindset. These may have been appropriate a generation ago, but are no longer appropriate to the innovation needs of the EU in the 21st century. Instead, an open innovation mindset is required.

Closed innovation mindset policies	Open innovation mindset policies
Focus on developing a large domestic/ European market.	Pursue global market opportunities.
Protect European companies from foreign innovators.	Invite external innovators in to spur greater competition and innovation.
Limit the number of foreign students and workers in Europe.	Encourage circulation of ideas by inviting foreigners to study and work in Europe, while also sending Europeans overseas.
Give subsidies and credits to the largest European firms to keep them innovating in their home country.	Provide the proper institutional structures for innovation and focus on SMEs.
Ensure that government funds go to domestic/European firms and avoid assistance to foreign companies.	Use government funds to stimulate greater SME formation and expansion, encourage innovation investments (whether by foreign or domestic companies) within the EU, and support export industry activities.

We have summarised our recommendations in five areas:

1. Education and human capital development

The EU is fortunate to have tremendous human capital resources at its disposal. Nonetheless there are some important changes to be made that would strengthen the excellence of research that emanates from this pool of human capital.

Increase meritocracy in research funding – Too many research programmes within the EU sprinkle money across all the member states, with insufficient competition for these resources. The result is politically popular; but economically, the funded programmes lack the excellence and scale to produce world class research and technology. Research funding competitions should move to the EU-level wherever possible, to reward excellence and promote the promising ideas of new scholars. The

European Research Council is a good step forward – and should be enlarged.

Support enhanced mobility during graduate training – EU graduate training is world class in some fields in some countries, but not in others. While this condition will not change quickly, individual researchers can be given world class training if they are supported in conducting part of their training outside the EU and at the world's leading centres. In turn, EU graduate schools can broaden training by inviting the most promising scholars from outside the EU. A better ranking system for European universities would help inject much-needed transparency into the system, allowing students to make informed choices as they move. Likewise, more flexible immigration policies would also increase Europe's available brain power.

2. Financing open innovation: the funding chain

Funding open innovation requires a broader set of funding tools, reflecting the different financial needs at each stage of the process in which new ideas move from research and development into full commercial exploitation.

Introduce the funding chain concept: Growing ideas into profitable businesses requires appropriate types of funding at each stage of the development and commercialisation phase.

A narrow focus on public subsidies for R&D inputs by firms is not in accordance with open innovation. The EU could start by encouraging member-states to grant tax incentives for small, R&D based companies.

Increase the pool of funds available for VC investment: The availability of VC funding is crucial to oil the innovation engine based on the establishment and growth of new ventures. Europe's VC market is dwarfed by the American market and this fact is slowing the growth and dynamism of the European economy.

Support the formation of spin-offs to commercialise research discoveries: Great technical ideas do not get commercialised because they are early-stage and too risky to be privately funded. Reflection is needed on how policy can help providing funding to early-stage ventures.

3. A balanced approach to intellectual property

One of the most powerful levers government has to stimulate innovation is to design intellectual property policies that reward innovative initiatives while also stimulating the diffusion of innovations throughout society. Ironically, in an open innovation world strong IP protection is vital, to permit firms to share knowledge; but at the same time a balance must be struck to ensure rapid flow of ideas.

Reduce transaction costs for intellectual property. Current IP policy is anchored in each member country of the EU, fostering multiple filings, multiple language translations, and creating much high costs for EU patents. We need to move to a single EU patent, backed by a unified judicial process, to lower the costs of patent protection to those of rival regions. Current costs are particularly onerous for SMEs.

Foster the growth of IP intermediaries.

There is a growing market for IP, and the EU should encourage the expansion of this market. In addition, it should fund research into the functioning of IP markets so that future policy can be based on new and better evidence.

Rebalance EU policy towards universities with publicly funded research. Too many universities are focused on maximising the royalty income they receive from publicly funded research. The focus on royalty income, encouraged by governments trying to capture as much value as possible from their funding, may limit the flow of knowledge to industry which, in turn, hampers the technological progress and competitiveness of the industry. A more balanced approach would be to give greater weight to the overall social and economic impact of publicly funded research, with particular emphasis on broadly diffusing the research output within society.

4. Promoting cooperation, competition, and rivalry

Competition is vitally important to innovation. It enhances the willingness of firms to take the risks that advance new thinking, new processes, and new markets in an innovative society.

Shift support from national champions towards SMEs and start-up companies. SMEs are powerful agents of innovation diffusion within a society. Even when large firms remain at the top, the presence of striving SME firms in their industries forces large firms to innovate more rapidly to keep ahead. Policies should support SME formation, expansion, and exports outside the EU.

Promote spinoffs from large companies and universities. Many innovative ideas start small, too small to be of interest to large companies. Many other ideas start inside a university lab, but require risk capital and entrepreneurial management to move into the market. Government can help facilitate these spin-offs by encouraging the transfer of IP to these spin-offs (perhaps providing tax incentives for large companies) and supporting the invested risk capital.

Focus on innovation networks. The locus of innovation is no longer in single large companies; but in innovation networks involving a mix of partners: universities, labs, start-up companies, multinationals, and governments. The relationship between these players largely determines the overall performance of an innovation system. The success of large firms hinges increasingly on their ecosystem.

5. Expanding open government

Government is not a bystander in the innovation system. It possesses a wealth of information distributed through a myriad number of databases that are often difficult to access. Government also buys innovation from many suppliers in society, and its opportunities to foster innovation through its procurement activities also deserve more attention.

Accelerate the publication of government data wherever possible. Citizens and companies can often spot wonderful innovation opportunities if given the necessary information. This has already been demonstrated through mashing data from different sources, and developing applications to analyse and interpret public data.

Utilize open innovation in government procurement. When buying new technologies, create and employ open innovation intermediaries to seek out solutions from anywhere in the world, vs. the usual suppliers to the government. The U.S. Department of Homeland Security, for example, has created a government organisation, SECURE, to procure defence and security-related technologies using open innovation.

Foster commercial application of technologies developed for the government. Public policymakers should encourage the commercialisation of technologies that have been developed for military, aerospace, road and railway infrastructure, and national security. Many of these technologies can be turned into interesting commercial applications, but this process will not happen automatically without government incentives.

8

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