E

WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

CDIP/8/INF/7 REV.
ORIGINAL: ENGLISH
DATE: APRIL 23, 2012

# Committee on Development and Intellectual Property (CDIP)

**Ninth Session**
**Geneva, May 7 to 11, 2012**

TAXONOMY-ANALYTICAL STUDY FOR THE PROJECT ON OPEN COLLABORATIVE PROJECTS AND IP-BASED MODELS (RECOMMENDATION 36)

*commissioned by the Secretariat*

1. The "Project on Open Collaborative Projects and IP-Based Models", approved by the Committee on Development and Intellectual Property (CDIP) in its sixth session envisaged, as a first step, the preparation of a taxonomy-analytical study. Member States requested to review and make comments on the first draft presented in the eighth session until January 31, 2012. The current draft incorporates the changes suggested.

2. Accordingly, the Annex to this document contains the above-mentioned study.

3. The CDIP is invited to take note of the information contained in the Annex to this document.

[Annex follows]

---

The views expressed in the study are those of the authors, and not necessarily those of the WIPO Secretariat or its Member States.

The study was prepared by Dr. Linus Dahlander, Assistant Professor, Stanford University and European School of Management and Technology (ESMT), Berlin, Dr. David Gann, Professor and Head of Innovation and Entrepreneurship, Imperial College Business School, London, and Dr. Gerard George, Professor and Director, Rajiv Gandhi Centre, Imperial College Business School, London

**TABLE OF CONTENTS**

## EXECUTIVE SUMMARY

1. In most economies, innovation provides the engine for economic growth or the means to accelerate growth and spread prosperity. The innovation process is changing. In part, it is becoming more collaborative, international and spans across organizational and geographical boundaries. It is being enabled by a new IT infrastructure, including the Internet, social networking, simulation, visualization and eScience technologies. Institutions that have access to this digital toolkit are likely to take advantage of faster, more efficient and effective innovation processes, enabling collaboration between problem seekers and solvers.

2. In high-income countries, dominance of the service sector as a proportion of economic activity is leading to the need for market-facing innovation in which ideas are developed and delivered at the point of consumption. This requires engagement with end-users and is reshaping innovation and IP regimes. Large international firms co-ordinate the extent of their collaborations to maintain strategic advantage.

3. There is limited systematic evidence in the literature on the development of collaborative innovation processes in emerging and low-income economies. The review highlights this area as nascent, but one that is rapidly gaining prominence. It is recommended to further research and evaluate the organization, management, benefits and constraints to collaborative innovation in these regions.

4. This report develops an analytical taxonomy to understand the role of intellectual property (IP) rights in collaborative, open innovation processes. It forms the basis from which WIPO and other institutions may develop a framework, toolkit, and infrastructure to support collaborative innovation projects.

5. This report is based on an extensive literature review and analysis of different forms of openness and appropriability regimes. The analysis includes a range of different types of initiatives categorized in three themes that:

   (a) facilitate the flow of knowledge between companies,
   (b) resolve ambiguity about ownership between companies, and
   (c) support innovation between companies and individual users.

6. Each theme reviews the type of openness, the means of appropriability, and underlying IP model that supports it, as well as potential benefits and challenges. These initiatives are used to varying extents across industries. Some initiatives have broader reach than others, such as Internet-based prize competitions.

7. The report assesses the relationship between open innovation and IP regimes in low-income and developing economies. It shows that the vast majority of academic papers focus on initiatives in developed economies: the evidence base and tools that can be derived from it are therefore heavily skewed towards experiences from these countries. The innovation context and maturity of IP regimes in developing economies require particular treatment and it is not clear that tools created from evidence in developed countries will be appropriate for those in developing countries. But new business models and low cost innovations provide a parallel avenue for locally-developed context-specific innovations that could benefit the Western world equally. Open innovation offers an opportunity to emerging and developing countries for fostering their economic growth. In such networked innovation ecosystems, a solid framework for effective IP management is more important than ever before. As a result, entry costs on the international market for technology will be incurred, particularly in terms of infrastructure and skills for the strategic management of open innovation collaborations.

## 1. INTRODUCTION

8. Innovation is a major driver of economic growth and competitiveness. Innovation processes are changing as organizations seek faster and cheaper ways to capture value from new products and services. The organization and geography of innovation is changing as firms seek faster, more effective and efficient ways of developing new products and services (WIPO 2011). The use of "distributed" or "open" innovation has received much recent attention from academics, managers and policy-makers. Most organizations do not have the capabilities or resources to innovate on their own. They need to collaborate with external constituents to acquire, develop and commercialize new ideas. Research has shown how this can enable organizations to leverage their internal innovation processes and R&D, to develop and exploit inventions with fewer resources and at greater pace. Chesbrough (2003: XXIV) argues "open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology".

9. It is widely recognized that innovation results from the combination of previously disconnected knowledge (Schumpeter, 1942; Nelson and Winter, 1982). To enable this, the use of intellectual property rights (IPRs) needs to strike a balance between providing incentives to inventors, whilst allowing for recombination of knowledge. Many internet-based initiatives have been formed with the intention of reducing the need for formal IPRs. To understand these issues, this report develops a framework based on contemporary work on the topic, highlighting what is meant by openness, how different means of appropriability apply in particular contexts, illustrated with examples from variety of initiatives.

10. A definition for open collaborative innovation has been developed through consensus between WIPO Member States in the Development Agenda project entitled "Open Collaborative Projects and IP-Based Models" (Recommendation 36)[1]. This defines open collaborative innovation "as the osmosis and reverse osmosis of knowledge across the porous membrane separating an organization or community and its environment". It can be promoted through a variety of arrangements that are explored in detail in this report.

11. The increase in use of distributed innovation processes can be explained by a combination of factors (Chesbrough. 2003; Dahlander and Gann, 2010). First, organizational boundaries have become more porous: people move between companies to a greater extent than previously throughout their careers. Some argue "not all smart people work for you". Companies therefore need to establish new ways of accessing talent. Second, information and communication technologies have enabled new ways to work, involving collaboration and coordination of people between organizations and across geographical locations. Third, rapid economic development in emerging economies is expanding markets, changing the division of labor in innovation processes. Fourth, IPRs have become more commonplace, enabling organizations to trade a wider range of technologies.

12. This report analyzes how openness and intellectual property rights (IPRs) interact. For example, how organizations manage collaborative elements of the innovation process to speed cumulative advance of ideas, while keeping specific ideas protected to enable appropriation of value. IPRs can both retard *and* enable the flow of technologies between organizations (Jaffe and Lerner, 2006). They can provide the mechanisms to enable partnership, and the necessary protections to ensure ideas are not misused or stolen. Research suggests that an effective IP system is vital to encourage the trade and interaction of external knowledge. In short, "the effective management of IP is crucial, not only in identifying useful external knowledge but

[1] http://www.wipo.int/edocs/mdocs/mdocs/en/cdip_6/cdip_6_6_rev.pdf

especially to capture the value of a firm's own IP rights" (OECD 2008). Some argue that trade associated with the exchange of IP rights is increasing rapidly in high-income countries (Gambardella et al., 2007). But IPRs also retard openness when organizations build patent portfolios as a means to gain bargaining power or block competitors.

1.1 TERMS OF REFERENCE

13. The objectives of this Taxonomy-Analytical Study are to:

(a) review existing innovation literature and studies on patents, including work done by other organizations, NGOs, IGOs in the area of open collaborative innovation, such as the WIPO Projects DA_16_20_01 (CDIP/4/3) and DA_16_20_02 (CDIP/6/5);

(b) map different open collaborative initiatives and the IP tools and models supporting them, including traditional approaches to collaborative innovation projects and newer approaches to problem-solving on the Internet, including the promotion of open source and creative commons;

(c) analyze and cluster the different initiatives by industrial classification such as health, agriculture, biotechnology, micro/nanotechnology, pharmacology, genetic resources and traditional knowledge, energy, climate change, software and information and communication technologies;

(d) develop a framework for understanding the benefits and challenges for open innovation initiatives and the different IP models and procedures that these initiatives are based on;

(e) identify emerging initial conditions and IP models for successful open collaborative initiatives.

## 2. REVIEW METHOD

14. This analytical taxonomy has been constructed using a systematic literature review approach (Higgins and Cochrane, Eds. 2006), extending the approach reported in Dahlander and Gann (2010). Their study searched the ISI Social Sciences Citation Index (SSCI) database for articles that had "open innovation" in the topic field. The topic field includes the title, key words and abstract in the database. A broad definition was adopted as the concept is used and published in a wide range of journals. This approach captures papers about how firms "open up their innovation processes" extending beyond specific references to "open innovation" or "openness".

15. ISI is generally considered the most comprehensive database for scholarly work and includes thousands of journals. ISI does not include books and the database lacks some important contributions to the field (such as Chesbrough's original book from 2003). The search for the Dahlander and Gann paper was conducted in August 2009 and included 701 papers downloaded to a local database. Since then, there has been a steady increase in the number of papers on open innovation. The search was updated for this report to include papers that have been published up to October 2011. The newly constructed database includes 1,302 papers.

16. All 1,302 abstracts were read and analyzed to assess whether they dealt with open innovation. When unsure, the full publication was downloaded and read to make this assessment. This screening resulted in a short list of 352 papers where the full paper was read and analyzed. The database includes all the detailed information about the publication, the references the papers cite, the authors who wrote the publications and their institutions.

17. All papers were categorized for the different forms of inbound and outbound innovation (Dahlander and Gann, 2010; Gassman and Enkel, 2006; van de Vrande et al., 2009). Figure 1 plots the number of papers that have been published each year on the topic. It shows a rapid increase from the Chesbrough (2003) book that spurred interest in the area (please see Figure 1).

18. In addition, a number of specific open innovation initiatives were analyzed from a list compiled in collaboration with WIPO. These initiatives were examined with regard to the type of openness and their underlying IP models. Some of the initiatives are well explored in earlier work, such as R&D alliances. Other newer forms of internet-enabled collaboration are also explained and analyzed. The search for evidence included wider enquiries using the ISI database to explore evidence published on specific open innovation initiatives.

## 3. ANALYTICAL TAXONOMY

19. Many actors engage in innovation processes, including companies, universities, private research institutions and government agencies. Innovation processes do not just comprise the organizations involved; they include the ways in which they work together. This has been the central idea explored in the literature on open and distributed innovation. What exactly "openness" entails is often unclear in this literature. But put simply, the literature highlights that valuable ideas and resources can be commercialized both inside and outside the organization. The study of "openness" is problematic, because scholars use the term to study divergent things; there is no commonly used definition (Dahlander and Gann, 2010). For instance, some scholars discuss openness with references to how companies source external ideas. Others focus on how non-core technologies or ideas developed within the firm can be licensed to others externally.

### 3.1 DIFFERENT FORMS OF OPENNESS

20. To clarify and define "openness" in order to understand what conditions it is beneficial, Dahlander and Gann (2010) categorized earlier work using the distinction of inbound and outbound innovation as a starting point. Inbound innovation refers to ideas and technologies arriving to the company, while outbound innovation refers to ideas and technologies leaving from the company. This paper further divided inbound and outbound innovation to interactions that are pecuniary versus non-pecuniary and proposed four different categories illustrated in the table below. The report discusses two different types of inbound innovation – Acquiring and Sourcing, as well as two forms of outbound – Selling/out-licensing and Revealing. This classification is illustrated in Table 1 showing that different processes and mechanisms are in play within the overall open innovation approach. To structure what scholars mean by open innovation in this way is more than a simple thought exercise. Only by specifying what scholars mean by "openness" it is possible to compare different initiatives, to determine under what conditions this is beneficial or limiting in supporting positive outcomes. (Please see Table 1).

#### 3.1.1. Acquiring

21. This type of openness refers to buying inputs to the innovation process from the market place: how organizations license-in and acquire expertise from outside constituents. Successful outcomes depend upon how companies invest in and organize resources to search and combine acquired expertise with their internal resources.

3.1.2. Sourcing

22. This type of openness refers to how firms scan and use the external environment as an input to the innovation process through informal means. Scholars who take this lens focus on how firms scan and explore their environment as a complement to their internal R&D. Research on R&D units in particular shows that they facilitate the absorption of external ideas and resources (Freeman, 1974; Allen, 1977; Tushman, 1977; Cohen and Levinthal, 1990; Zahra and George, 2002). Following this tradition of research, Laursen and Salter (2004:1204) define openness as "the number of different sources of external knowledge that each firm draws upon in its innovative activities".

3.1.3. Selling/Out-Licensing

23. This type of openness refers to how firms commercialize their inventions and technologies through selling or licensing-out resources to other companies. Companies thereby generate value from unused knowledge and IP by enabling other, more suitable firms to commercialize. By selling or licensing IP, companies profit from allowing technologies to be commercialized by others. To acquire inputs to the innovation process requires that buyer and seller reach an agreement and suitable appropriability regimes are required to enable the seller to disclose information. To overcome this paradox, firms often require that inventors have formal IPRs in place before they work together.

3.1.4. Revealing

24. This type of openness refers to how internal resources are revealed externally. Companies promote adoption of their technologies that they later benefit from or by preventing their competitors from claiming ownership of. The premise is that openness, caused by voluntarily divulging information to outsiders, can improve the probability of being successful (Alexy and Henkel, 2011; Harhoff et al., 2003; Henkel, 2006; von Hippel and von Krogh, 2003). Henkel (2006), for instance, suggests that firms adopt strategies to selectively reveal some of their technologies in order to elicit collaboration, but without any contractual guarantees of obtaining it.

3.2 DIFFERENT MEANS OF APPROPRIABILITY

25. All forms of openness are affected by the appropriability regime surrounding the knowledge behind the invention. In contrast to land and labor, knowledge has two important characteristics of a public good: it is non-rival and non-excludable. Non-rivalry suggests that, unlike for example an oil-well, it can be used by many without the risk of depletion. Non-excludability refers to the difficulty in preventing others from using it. Expropriation, or illegal imitation, is therefore often difficult to detect and enforce (Liebeskind, 1996). But when knowledge becomes freely available and others can potentially free ride, this creates disincentives to invest in R&D.

26. An appropriability regime affects an innovator's ability to generate rents from innovation (Teece, 1986) and therefore influences the incentive to innovate. An appropriability regime is related to the features of the core knowledge in the innovation and the possibilities of institutional protection, and is said to be "weak" when the underlying knowledge is hard to protect and "tight" or "strong" where it is relatively easy. With weak appropriability regimes, the profit margin will be driven to zero (Katz and Shapiro,1986), and in the absence of appropriability, firms have to rely on speed to market, timing and pure luck (Teece, 1986). Strong appropriability regimes provide incentives to invest in innovative activities, but can endanger the cumulative advance by limiting the use of the underlying knowledge. Weak appropriability regimes, in contrast, often result in knowledge becoming widely distributed, and this can create disincentives to innovate.

3.2.1. Formal means of appropriability

27. Formal appropriability mechanisms include patents, utility models, copyright and industrial design rights. These IPRs can create an incentive to invent, helping the creator generate returns on their investments. We focus on those means that have been created to incentivize investments into innovation, and thus ignore trademarks that are usually considered an instrument to resolve information asymmetries. Patents are exclusive rights granted by a national or international agency to an inventor for a limited time period. This temporary monopoly is granted in exchange for public disclosure. Although the exact criteria for patents differ across agencies, the criteria are usually utility, novelty and non-obviousness. Empirical work has shown that the effectiveness of patents as protection of knowledge differs across and even within industries (Levin et al., 1987). Copyright, on the other hand, protects "literary and artistic work such as novels, poems and plays, films, musical work, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs"[2]. Copyright includes the right to copy, distribute and change the work. These exclusive rights are usually given for a limited time period.

3.2.2. Informal means of appropriability

28. Innovation takes place even when there is weak institutional protection of ideas (Mansfield, 1986). Some firms rely on secrecy (Arundel, 2001) or other means of protecting knowledge and information to appropriate returns from innovations. There are many industries (see Levin et al., 1987 for an overview) where formal means of appropriability are not effective, yet the appropriability regime remains strong as companies can rely on informal means of appropriability. These informal means include, for example, complementary assets and first-mover advantages. Complementary assets are those assets that are necessary for the commercialization of an invention, but that are not directly linked to the invention. Teece (1986) observed that an outstanding invention is not a guarantee of successful commercialization: this process requires complementary assets that need to be used in conjunction with the knowledge about the invention, such as distribution, service, manufacturing etc.

29. In some cases, network effects can be an advantage for those products and services where the benefit that one user derives increases with the number of other users (Katz and Shapiro, 1985). New users are therefore influenced by what previous users have chosen, which causes a path-dependency (Arthur, 1989). Firms in such industries can therefore appropriate returns by building a large user base and creating a lock-in. Firms give away and signal their work to get a head start. Related to this is the discussion about lead-time and first-mover advantages. Lieberman and Montgomery (1988) argue that pioneering firms can gain a first-mover advantage by acquiring superior resources and capabilities, by entering the market in an early phase. These firms gain access to distribution channels, gain reputation, and create linkages to other firms, which can create an advantage compared to later entrants.

30. Secrecy refers to the keeping inventions secret within the organization. In studies across industries, secrecy typically ranks as one of the most commonly used methods, and one of the most efficient in keeping competitors at bay (Levin et al. 1987). Secrecy often provides better protection for process innovation than for product innovations, as those are harder to reverse-engineer.

[2] http://www.wipo.int/export/sites/www/ipstats/en/wipi/pdf/941_2011_annex.pdf

3.2.3. The private-collective innovation model

31. Some scholars have expressed concerns that strong IP rights could potentially make it difficult to cumulatively build upon knowledge (Heller and Eisenberg, 1998). In certain situations, individuals share their knowledge with others as proposed without commercializing their innovations (von Hippel, 1988; Harhoff, Henkel and von Hippel, 2003). Much reasoning suggests that in the absence of institutional infrastructures, people often maximize their own well being at the expense of the collective: free riding becomes an issue (Ostrom, 1990; Hardin, 1982). Rational and self-interested individuals can wait for others to contribute and can free ride on others' work (Hardin, 1982; Olsen, 1967). Olsen (1967) suggested that collective action must be accompanied by private excludable selective incentives that reward contributors and punish non-contributors.

32. Some of the initiatives we observe, particularly in the online context, suggest that individuals freely share their innovations. People are often less self-interested than many theories would suggest, and there are a host of reasons for why people share their ideas with others. People often derive private benefits from developing and sharing ideas with others, such as reputation, joy, signals, etc (von Krogh et al., forthcoming; Kogut and Metiu, 2001). Von Hippel and von Krogh (2003) proposed the term "private-collective innovation model" to illustrate that the private investment and collective action models are intertwined in practice. In the private-collective model, actors with divergent interests often find new ways to collaborate (Dahlander and Magnusson, 2005; 2008). Firms obviously seek to gain competitive advantage and derive profits, whereas individuals that contribute often want to make sure their shared ideas are available for others. This requires careful consideration from all parties, such as developing compatible licensing practices (see also Lerner and Tirole, 2002).

3.3 SUMMARY OF TAXONOMY

33. This analytical taxonomy focuses on two central aspects to innovators. First, it distinguishes between different types of openness that highlight the nature of flow information, knowledge and ideas across organizations. Our taxonomy distinguishes between two forms of inbound and two forms of outbound innovation that brings clarity to "openness", what is being exchanged and the nature of that exchange. Second, it distinguishes between formal and informal means of appropriability illustrating what organizations can do to protect their ideas and innovations across organizational boundaries. From this reasoning, it is possible to classify different types of initiatives using this taxonomy.

34. In summary, this taxonomy brings a deeper understanding of the complexity in terms of the processes of developing, commercializing and protecting knowledge. Firms can rely on several means of protection, and their effectiveness varies largely depending on the industry, as well as to the specific situation of the firm (Levin et al., 1987). Different means of appropriability are often complementary and used in tandem. At other occasions, the relative inefficiency of one means of appropriability is typically compensated by greater reliance on another. For instance, in industries where patents provide little protection to inventors, firms often rely on building first-mover advantages, secrecy or reliance on complementary assets. To fully understand openness and the role of intellectual property, one therefore has to consider various means of appropriability.

## 4. ANALYZING DIFFERENT INITIATIVES

35. This section sets out various arrangements to cope with the balance between openness and appropriability. We selected a range of different initiatives commonly cited in the academic literature with regards to means in which organizations make use of the external environment in their innovation processes. We categorized these into three themes, those that facilitate:

(a) the flow of knowledge between companies;
(b) resolving ambiguity about ownership between companies;
(c) cumulative innovation between companies and individual users.

36. For each, we reviewed the type of openness, means of appropriability and underlying IP model that support it, as well as potential benefits and challenges.

### 1.1. FACILITATION OF FLOW OF KNOWLEDGE BETWEEN COMPANIES

37. A number of studies concur that formal relationships between companies has increased rapidly in recent decades (Schilling 2010). A summary of the initiatives, with their type of openness and means of appropriability is summarized in Table 3a (please see Table 3a).

#### 4.1.1. Licensing

38. In a licensing agreement, a licensor grants a license to authorize the use of a protected invention to a licensee to avoid infringement claims. Licenses include several conditions with regards to the exact terms, territory of where it can be used, and renewal provisions.

39. Licensing enables an organization to bring inventions to the market through an external organization suitable for commercialization. Many organizations develop technologies for licensing purposes. There are many obstacles to license invention for use by someone else; Gambardella et al. (2007) propose that “the market for technology” has a potential to be significantly greater if licensing mechanisms were improved. This is a figure that needs further empirical evidence, but it has been suggested that the markets for technology are only incipient and below its full potential (WIPO 2011).

40. Patents facilitate trading by providing opportunities for firms to overcome the disclosure paradox (Arrow, 1962). This paradox suggests that when a potential licensor has to reveal his/her underlying knowledge to the licensee, the licensee could potentially act opportunistically and use it without paying. This creates a market failure where firms would avoid trading, but IP facilitates this by protecting the underlying knowledge. Understanding the disclosure paradox calls attention to the means of appropriability in open innovation, and how firms attempt to be open yet are able to appropriate commercial returns from their innovative efforts. To overcome this paradox, firms often require that inventors have formal IPRs in place before they work together. In this view, IP is viewed as a currency for collaboration.

#### 4.1.2. Sub-contracting

41. Sub-contracting refers to agreements that organizations make with an external partner to conduct a specific task. It is associated with tasks that the contractor has the ability to do internally, but contracts to an external partner to gain flexibility. It requires that a contractor provides specifications of what needs to be delivered to the supplier (Day, 1956). Sub-contracting is used heavily in the manufacturing industries, especially in geographically-concentrated clusters (Piore and Sabel, 1984).

4.1.3. R&D alliance

42. An R&D alliance is a formal relationship between two or more parties to pursue joint research activities that allow them to share and develop new knowledge. It is common in high-tech industries where the knowledge frontier is expanding. R&D alliances allow organizations to overcome internal resource constraints, gain flexibility, and recombine complementary knowledge that another organization owns. The potential downsides include a greater reliance on external constituents, increased coordination costs and potential ownership problems.

4.1.4. Joint ventures

43. A joint venture is a business agreement in which parties agree to develop, for a finite time, a new entity and new assets by contributing equity. They exercise control over the enterprise and consequently share revenues, expenses and assets.

4.2. RESOLVING OWNERSHIP BETWEEN COMPANIES

44. In recent decades, the total number of patent applications has increased rapidly. Many scholars argue that patents are used for other purposes than to protect innovative products and processes which have been commercialized. Companies can use to block their competitors from gaining a technical advantage or, as a resource in negotiations and to prevent litigations (Hall and Ziedonis, 2001). As a result, the pool of potential inventors is lowered, as not all can afford to obtain the necessary licenses to use the knowledge protected by the patent. Various attempts have been made to tackle issues of companies building patent thickets that threaten the cumulative advance of technologies (Shapiro, 2001; Lanjouw and Schankermann, 2004; WIPO, 2011). Cross licensing, patent pools and open technology standards have been developed as solutions to cope with patent thickets. Table 3b summarizes initiatives that are designed to cope with this challenge (please see Table 3b).

4.2.1. Cross-licensing agreement

45. Cross-licensing agreements refer to when two or more parties grant a license to one another for the right to use certain patents that each own. In cross-licensing agreements, typically none of the involved parties pay royalties when the product is brought to market, although exceptions exist. Shapiro notes how this allows organizations to produce products without infringing and price products without having to pay royalties per product to the other party (Shapiro, 2001).

4.2.2. Patent pool

46. A patent pool is a consortium of two or more companies that agree to cross-license patents in a technological area. Patent pools are specific for patents, whereas cross-licenses can also include trademarks and copyright. This is often used in situations of patent thickets where companies were previously blocking one another as a means to make inventions reaching the market. Patent pools are efficient if technologies are complementary rather than substitutes.

47. This has been discussed by courts as potentially anti-competitive. These courts typically approve of patent pools that circumvent blocking patents, allowing technologies to be brought to

the market. They typically disapprove of pools that decrease R&D expenditures and limit competition between different technologies (Scotchmer, 1991). Pool members are free to exclude competitors, although courts can rule against this if they pool members have a too dominant position.

| **Text box 1: MPEG patent pool** |
| --- |
| MPEG-2 is a technology for coding standards used for videos in TVs, DVD players, computers, cell phones, cameras and a range of other products. To develop the technology, the MPEG Licensing Authority, a private company, acquired rights from a couple of dozen companies that together comprised more than 600 patents. Many companies thus pool patents that are then licensed for a fee to many other organizations that use the technology.<br><br>Multiple patent holders thus need to negotiate to make the arrangement possible to create profit-sharing mechanisms and agree on fees for external parties. This patent pool has been successful in establishing the technology as a standard, creating an opportunity for the companies to profit more than they would have done alone.<br><br>Website: http://www.mpegla.com/main/default.aspx |

4.2.3. Defensive patent pool

48. One or more patent holder's cross-license their patents and pledge they will not be used to sue for infringement. Rather than selling the rights to using the technology, the defensive patent pool is used to facilitate the cumulative advance.

| **Text box 2: Open Invention Network** |
| --- |
| The Open Invention Network is an intellectual property company that was established in 2005 to promote the Linux operating system. Several large companies, including among others IBM, Novell, Philips and Sony, have backed it.<br><br>The Open Invention Network provides an intellectual property model where patents are shared and are available without royalties to any organizations that agrees not to assert its patents against Linux. As many companies are relying on Linux code that they modify and extend in their devices, they have an incentive to keep it as open as possible. For companies that invest heavily in open source components, this is a means for keeping the code available in the future.<br><br>Website: http://www.openinventionnetwork.com/ |

4.2.4. Open standard

49. An open standard is a standard that is publicly available and has various rights to use associated with it. In relation to patents, the term is often used to dictate "reasonable and non-discriminatory" royalty fees and other licensing terms.

**Text box 3: Internet Engineering Task Force**

A common cited example is the Internet Engineering Task Force whose mission is to "make the Internet work better by producing high quality, relevant technical documents that influence the way people design, use, and manage the Internet" (http://www.ietf.org/about/mission.html).

IETF has no official mandate to develop standards, but has emerged as a de facto standard developing organization (Mowery and Simcoe, 2002). Backbone technologies of the Internet, such as the TCP/IP protocol, is developed and maintained by IETF.

Any person can participate in the organization, and be updated about the progress. All documents, mailing list, attendance lists and meeting minutes are available online. Although many discussions occur throughout a year, IETF participants also meet at a yearly meeting.

There are many corporate interests in IETF, but people take part as individuals (Bradner, 1999), even though they have affiliations with companies and other organizations.

Website: http://www.ietf.org

## 4.3. FACILITATING INNOVATION BETWEEN COMPANIES AND USERS

50. Co-creation of innovation involving suppliers and users has a long tradition of study in the innovation literature (von Hippel, 1988; von Hippel, 2005; Freeman, 1974). The emergence of the Internet has allowed organization to tap into geographically dispersed user groups. Examples are diverse and range from the design of T-shirts, developing new software code, to finding gold in Canada. It is thus necessary to develop a more systematic way to think about these initiatives. Table 2 summarizes the resulting framework that captures the diversity of initiatives (please see Table 2).

51. One form of this type of open innovation, or "crowdsourcing", refers to the act of outsourcing to a group of individuals, rather than an assigned person (Afuah and Tucci, 2011). People self-select to solve tasks, expressing their opinions or articulating new problems to be solved (Dahlander and O'Mahony, 2011). In one form of crowdsourcing, the task is outsourced to a pool of potential solvers and the best solutions are selected. In another form of crowdsourcing, people in the crowd collaborate to advance the knowledge frontier by sharing knowledge and building upon each other's work. In both forms the task is being distributed to a pool of solvers, but they differ in their extent of connectivity among the participants that take part. For example, IBM has, for a number of years, been using simultaneous online brainstorming sessions linking members of its R&D team with many people in other organizations. These "innovation jams" can involve several hundred thousand people, typically engaging over a 72 hour period, managed using the Internet with results analyzed in the cloud.

52. What the distributed pool of external people is being used for also differs. In one form, problems are well defined and it is possible to develop distinct evaluation criteria. It is a form of targeted prizes formalized into standards that solutions can be evaluated against (Scotchmer, 1991). Netflix, for instance, initiated a prize to people who would be able to improve their recommendations by at least 10%. Another example is Innocentive that awards a pre-defined sum to that person that can solve a given task.

53. Sometimes potential options exist but the external group of people can be used to gain a better sense of the aggregated preferences. The logic is that even people slightly better than chance can make informed decisions if they are many to get feedback about possible options to pursue. For instance, the t-shirt company Threadless has been very successful in using its

community not only for developing the design, but also having them to vote between different possible designs that could be printed and sold.

54. In a third form, there is no pre-defined problem but external individuals can either suggest novel ideas to an organization or work jointly in developing new solutions (Alexy et al., 2012).

55. Digital technologies are increasingly being used as a core infrastructure, providing a toolkit to underpin modern innovation processes. These technologies include connectivity to ideas through the Internet and social networking, the use of simulation and visualization technologies, and in some industries, the use of eScience (Dodgson, Gann and Salter, 2005; Gann and Dodgson, 2007). These technologies have the propensity to enable new forms of collaboration between producers and users, such as in the processes developed by P&G (Dodgson, Gann and Salter, 2006). The use of simulation and visualization technologies to engage with a wide range of stakeholders is being used to support collaborative processes that result in decisions about the introduction of an innovation: this was the case in the collaborative development of fire-safety designs and technologies in buildings (Dodgson, Gann and Salter, 2007).

56. Table 3c summarizes initiatives designed to facilitate innovation and interaction between companies and users (please see Table 3c).

4.3.1. Innovation inducement prizes and idea competitions

57. Prizes are an alternative means to reward inventors for their investments, and have long been around. The Royal Observatory was famously established in the 17th century with the ambition to improve navigation at sea, and solve the longitude problem. After the in-house astronomers had failed for decades, a contest was initiated that offered an enormous sum in today's money terms for a solution to the problem. A carpenter surprised the Royal Observatory by providing a solution that involved developing an accurate clock that worked during rough sea conditions of rolling ships and extreme weather. The solution was unexpected as most others tried to use astronomy, and the solver faced problems of being recognized for many years. Another old and often-cited example is the prize offered for people who could find improved methods for food preservation that would be used by Napoleon's armed forces (Schotchmer, 1991). KEI (2008) provide comprehensive list of historical as well as contemporary use of prizes to induce innovation. Prizes were popular in the 18th and 19th century and were used to address diverse problems. They were less used in the 20th century, but have more recently enjoyed a renaissance enabled by new technologies and renewed public interest. Proponents argue that prizes can be efficient in finding "unexpected" solutions from individuals outside organizations. Prizes are typically divided into *targeted* and *blue-sky* prizes (Scotchmer, 1991). Targeted prizes are formalized into standards that solutions can be evaluated against *ex ante*, whereas blue-sky prizes refer to where the type of invention is not specified in advance but rewarded *ex post*. For blue-sky prizes, judges are allowed to "know it when they see it" (Scotchmer, 1991: 40).

58. Ex ante prizes are useful when the goal can be defined in concrete terms, but where there are multiple or undefined ways to achieve the goal. These prizes are also inclusive for all potential people who decide to work on the challenge, not only those that are awarded a scientific grant of direct financial compensation. As a result, some solutions may emerge from those people that were considered peripheral to the challenge. A potential challenge with ex ante prizes is that not all people have the resources to tackle the challenge. Only winners receive the prize, and contestants thus have to assemble the necessary resources to tackle the challenge. In addition, it could mean duplicate work as there are many people working simultaneously trying to solve the same challenge (Scotchmer, 1991). For an ex ante prize competition to work, it needs to be specified in advance what the victory conditions are, which is inherently difficult as science is uncertain.

59. When prize competitions are designed appropriately, they can reach a wider audience of potential solvers. More recently, some have called for the importance of prizes to encourage sharing of knowledge, materials, data and technology (KEI, 2008; Love & Hubbard, 2005; Love and Hubbard, 2008). There is little academic research on how prizes can be used to encourage sharing. In a comprehensive overview of prizes, KEI (2008) notes how "the literature on innovation prizes is surprisingly incomplete". Prizes can be used as an alternative incentive to monopolies for encouraging efforts to develop new solutions. Instead of awarding patents as temporary monopolies, prizes can potentially allow for greater access to inventions and the opportunity to develop cumulatively upon what has been already invented. In that sense, prizes are seen as especially important where it there are societal benefits of marginal cost pricing, such in the development of neglected diseases.

**Text box 5: Innocentive**

Innocentive is an example of a company using targeted prizes. This company connects "seekers" facing unsolved problems with a diverse pool of potential "solvers". Innocentive helps with the problem formulation and provides access to a list of scientists and engineers that may have potential solutions to the problem. In return for solving the problem, an individual receives a pre-defined sum, usually in the range of $10,000 to $100,000. Jeppesen and Lakhani have found that the solvers to these problems often emerge from a different domain from where it originated. These people often tackle problems from a fresh angle and can connect the problem to already-made solutions within their domain of expertise.

Innocentive thus works as an intermediary between previously unmatched seekers and solvers. To overcome many of the intellectual property challenges, Innocentive force its seekers to intellectual property audits to make sure the proposed solution is not used if it is not awarded. They can also enforce seeking companies to pay out money if the solution is considered to live up to the requirements of the challenge. The solutions submitted by the solvers are confidential, to ensure secrecy to outsiders.

Although there exist some detailed case studies on Innocentive, there is very little work comparing several different platforms, which makes it difficult to assess their relative efficiency.

Website: http://www.innocentive.com/

| **Text box 6: P&G Innovation Challenge** |
| --- |
| The P&G Open Innovation Challenge is an example of blue-sky prize. This was an experiment developed by Procter &Gamble, the UK government agency NESTA, British Design Innovation and Oakland Innovation. The latter three worked as intermediaries between P&G and potential outside inventors on an open ended call to develop new inventions on fabric care and health and wellness products. According to their statistics, 72 ideas were submitted by 25 firms, and eight of the most promising ideas received partial funding and support to transform the ideas into viable business solutions.<br><br>The intellectual property was designed so that P&G could first evaluate the idea and decide if it was worth pursuing. If they decided to reject the ideas, the originator retained the rights so they could commercialize themselves or team up with another organization. The underlying IP model is thus based on the idea of creating a trusted intermediary that matches seekers and solvers.<br><br>Website:<br>http://www.nesta.org.uk/publications/guest_articles/assets/features/pg_corporate_open_innovation_challenge |

60. Brunt et al. (2008) conclude "while the administrative costs associated with a prize system may be high, our evidence suggests they are counterbalanced by substantial output effects. Based on almost a century of award data, we conclude that innovation inducement prizes do work". The premise that prizes designed to encourage sharing and access to knowledge is important to recognize, but there is little empirical research on this important topic.

4.3.2. Open licensing

61. In an era of digital information and technologies that allow for rapid exchange, some people have expressed concerns about the limits of traditional copyright, preventing copying, distribution and changing the work (Hargreaves, 2011). This is particularly evident in the creative commons and open source licenses (see e.g. Bloemsaat and Kleve. 2009). These initiatives use the existing legal framework, modifying it to allow for others to build, change and redistribute to varying degrees. Here we elaborate on free and open source as well as creative commons licenses. Although these licenses have been developed to protect achievement from being closed from others, commercial interests remain. Companies find new ways to make money, and creators can benefit from a wider circulation (Dahlander and Magnusson, 2005; Foong, 2010)

| **Text box 7: Creative Commons licenses** |
| --- |
| The idea of Creative Commons is to provide free, publicly available infrastructure that works better in the Internet era. They do so by developing different versions of licenses that allow the creator of original material to waive certain rights to the benefits of users and add-on creators that have more flexibility. This allows content to be "copied, distributed, edited, remixed, and built upon, all within the boundaries of copyright law".<br><br>Creative Commons licenses require existing legal frameworks, and the licenses have been ported to over 50 jurisdictions. A creator can go through a simple schema that help the creator to strike a balance between "all rights reserved" and waive all rights to varying extent. |

| **Text box 8: Wikipedia** |
| --- |
| Wikipedia is an online dictionary that has developed at an astonishing pace. Since its inception in 2001, more than 20 million articles have been written in close to 300 languages. About 90,000 contributors add and modify text to provide a reliable dictionary.<br><br>Wikipedia relies on different form of open licensing to ensure that content remains possible to access and modify. Wikipedia previously used a free software like license (GNU Free Documentation License) to a Creative Commons license. According to proponents of the new licensing practice, this enable content to flow in and out of the site with greater ease.<br><br>Website: http://www.wikipedia.org |

| **Text box 9: Open source licenses** |
| --- |
| Open source and free software licenses are used to allow software to remain free. The central idea of open source licenses is to use the existing legal framework of copyright and modify it to ensure that extensions are kept public rather than private (Dahlander, 2007). Richard Stallman created "copyleft" that grant rights to all future users, rather than giving the developer a copyright to the source code. Stallman's copyleft was implemented in the General Public License (GPL), which is very strict in terms of its requirement for developers to release the source code of derived work. Run the program, study and adapt after your needs, improve the program and redistribute those improvements to others. Providing access is important to ensure this. O'Mahony (2002) states that licenses such as the GPL are a critical cornerstone for the open source movement for three reasons: (1) enabling communities to collectively pool their work and avoid the risk of its being appropriated by firms for proprietary use; (2) using the existing legal framework to protest against proprietary software; (3) providing a normative ground for users and developers so that improvements will be put back on the web.<br><br>Websites: http://www.opensource.org/ and http://www.fsf.org/ |

4.3.3. Open access

62. Some scholars have sought to transfer the experiences from open source to other settings (see e.g. Guadamuz and González, 2006; Fitzgerald et al., 2010). Some of the challenges of building common ground between companies and individuals in the context of open source have a history of study in the context of science (Dahlander, 2007). Following the Bayh-Dole act in the 1980s, commercialization of research in the forms of university patenting, technology transfer offices and newly established businesses by researchers surged. This created tensions between those who felt that science should be free versus those who took a more pragmatic stance (Owen-Smith and Powell, 2001), similar to those observed in open source between companies and people in the community (O'Mahony and Bechky, 2008). Scholars have debated how the lessons from open source and creative commons can be extended to protect scientific research from being only used by a few (Guadamuz González, 2006). When published in most journals, publicly funded research is copyrighted by the publisher, making it difficult to access for people who lack subscriptions. Proponents of open access argue that this positively affects the degree to which others build on earlier findings (Carroll, 2011).

63. Evans and Reimler (2009) separate the effects of open and electronic access looking at a broad range of articles from 1945 onwards. They conclude that open access yields increased citations per paper with about an 8% increase. It is worth noting that electronic access gives a bigger uplift in citations than open access, but the pattern changes in the developing world. They find that "the influence of open access was more than twice as strong in the developing world but was less apparent in the very poorest countries where electronic access is limited". This suggests that open access particularly affects scholars in the developing countries that may not be able to afford to gain access to scientific findings through subscription journals.

4.3.4. Boundary organizations

64. Many of the Internet initiatives develop solutions beyond new forms of licensing practices. O'Mahony and Bechky (2008) look at how organizations with different motivations (companies and software developer volunteers) establish boundary organizations (often in terms of non-profit foundations) to help them organize around shared interests to facilitate the cumulative advance of technologies. These foundations represent the actors that take part, and are elected and governed by those who are active contributors to the project. To prevent them from being "hijacked" by one strong corporate interest, there are various structures in place to ensure the foundation represent the preferences of the many and not a selected few. These boundary organizations stipulate rules and norms with regards to intellectual property beyond what a license scheme can do.

| **Text box 10: The Eclipse foundation** |
| --- |
| One example is the Eclipse foundation that was originally created by IBM in 2001. Over time, Eclipse became more independent and developed a not-for-profit corporation to allow a vendor neutral and open, transparent community to be established around Eclipse. From being heavily dominated by IBM contributions, as it opened up for other organizations, IBM's share declined. Today more than 70 different companies are members and actively contribute to the project. As the foundation gradually became more independent from IBM, the amount of collaboration increased between those companies that are members. |

| **Text box 11: The BiOS initiative** |
| --- |
| The BiOS initiative is "an effort to develop new innovation ecosystems for disadvantaged communities and neglected priorities." They seek to do so by using "communications tools of the Internet and open source to generate open access to capabilities for innovation". The interesting aspect of the BiOS initiative is that they use practices of the software industry and try to extend those to the biological sciences and agricultural biotechnology. The idea is to share tools and platforms to allow for a faster development of technologies.<br><br>When using BiOS instruments and tools, "licensees cannot appropriate the fundamental kernel of a technology and improvements exclusively for themselves." The technology that forms the basis for follow-on technologies remain the property of the inventor, but improvements and extensions can be shared with others. Access to the technology requires that the licensees will not prevent others from using the technology who has pledged to follow these guidelines.<br><br>According to BiOS, three conditions are necessary to access technologies:<br>"To share with all BiOS licensees any improvements in the core technologies as defined, for which they seek any Intellectual Property protection.<br>To agree to not assert over other BiOS licensees their own or third-party rights that might dominate the defined technologies. |

| **Text box 11: The BiOS initiative** |
| --- |
| To agree to share with the public any and all information about the biosafety of the defined technologies."<br><br>Website: http://www.bios.net |

4.4. SUMMARY OF FINDINGS

65. To further analyze these initiatives, they were coded for whether they use each type of openness and means of appropriability. A simple coding scheme (low, medium, high) was adopted by reading the academic literature on the topic. This allowed an investigation of differences and similarities across them. Several notable findings emerged from this exercise:

66. First, while it is common to think about one type of openness, in reality companies combine several different types. Only a handful of academic papers systematically analyze combinations of openness (see e.g. Acha, 2008; van de Vrande et al., 2009). It is clear that "coupled" models have the possibility to combine complementary types of openness. The analysis reveals how these are intermingled in specific initiatives. Two patterns stand out. Revealing and sourcing are often coupled: companies reveal technologies to facilitate the general development, and then try to source what is being developed. This is especially pertinent in fast-moving industries where gaining first-mover advantages is critical. Likewise selling and acquiring are often coupled: companies try to streamline their activities by selling technologies that are on the shelf and in return by in ideas and technologies from the market place. These initiatives suggest that organizations try to be more active in finding the best potential company to commercialize technologies. Even though this is on the rise in many industries, it has been argued to have even greater potential (Gambardella et al., 2007).

67. Second, the absence of formal means of appropriability is often compensated by a greater reliance on informal means of appropriability. Put differently, where patents and copyright do no apply, companies use first-mover advantages and complementary assets as tools to protect their innovations (Levin et al., 1987). There are also situations where companies use combinations of different means of appropriability to protect their innovations, suggesting that they have complementary roles.

68. Third, many of the Internet enabled tools that have been designed with the intention to increase interactions between companies and users modify existing IP rights to facilitate this process. For instance, open licensing such as open source and creative commons licenses, use existing copyright law to make sure some rights are waived (rather than protected) for future users to enable people to use on another's code, musical songs, or other creative achievements. In addition, many of these internet enabled initiatives have to spell out exactly how rewards are going to be divided and form non-disclosure agreements and monitoring mechanisms so that ideas are not stolen.

## 5. ANALYSIS OF INITIATIVES BY INDUSTRIES – WHERE DO THEY APPLY

69. Recent research on open innovation initially focused on case studies of large US companies in high tech sectors. From 2006 onwards, case studies of other industries have emerged as well as large-scale empirical studies that span across industries.

70. The Industry Classification Benchmark (ICB) developed by Dow Jones and FTSE was used to analyze how these initiatives are used across industries. The ICB taxonomy uses a

system of 10 industries that are further divided into 20 “super sectors”. The report uses those super sectors as a broad way to distinguish between different industries. These initiatives were analyzed using the database described in the methods section as well as further analysis of the Thomson ISI database. Most papers explain their research context, and this provided the opportunity to analyze how initiatives are more common in some industries than others. In addition, a report from Cosh and Zhang (2011) informed this exercise. This approach has obvious shortcoming, and needs further evidence. Figures 2a-h shows the extent to which the different initiatives apply in different industries. Two noteworthy findings emerge from this exercise (please see Figures 2a-h).

71. First, it appears that some initiatives have much broader reach than others, as documented in the literature. For instance, prize competitions have gained renewed interest with the emergence of the Internet assisting in eliciting and matching knowledge across a vast number of people that take part. These prize competitions have been used in a broad set of industries to broadcast problems needed to be solved. Other initiatives, such as open licensing, have a much more narrow scope. They are mostly used in the technology intensive industries such as software as well as in media, to allow for cumulative advance. These seem to work well when the underlying technologies advance in more incremental steps at a rapid pace, rather than more discrete.

72. Second, these results illustrate that there is no “one recipe fits all”. The extents to which initiatives are used across industries vary significantly. Some industries are much closed than others. For instance, the defense industry is very closed, only cooperate with other defense industry companies and rely on trade secrets.

73. The Taxonomy-Analytical study cannot draw any conclusions here more than to recommend further research. There is simply too little current research from which we can draw conclusions.

74. The authors of this report were able to draw insights from discussions with Heads of R&D and Chief Innovation Officers at a number of Fortune 500 and FTSE 100 businesses. These suggest that large international businesses take a strategic approach to “openness”. One company had a well developed system for licensing-in technology and an equally clear policy against licensing-out, or collaborating with external partners. Others exhibited strategies with varying aspects of closure to collaboration. In other words, it is apparent that international businesses participate in aspects of open innovation that best suit their overall strategies for developing and exploiting intellectual property where “openness” fits their specific interests. Whilst there is growing interest in assessing the benefits of collaborating in international innovation networks, many large firms probably continue to operate a “closed” strategy by default in order to protect what they see as their core assets and markets. We suspect that these strategies vary across sectors. Surveys of CEOs provide evidence of continued concern that open innovation practices may leads to IP leakage. Intellectual property theft is viewed as the most important risk of global innovation networks.

75. An OECD report suggests that these patterns vary with the nature of technology and market sector (OECD, 2008). Industries characterized by short technology life cycles, such as ICT, may seek external partners to enable them to stay abreast of developments inside and adjacent to their industry. Those with longer technology cycles and strong appropriability regimes, such as pharmaceuticals, mainly search externally to keep in touch with developments in research. Further research is required to assess the extent of open and closed practices and their underlying strategies within and between large international firms.

## 6. RESOURCE CONSTRAINED INNOVATION PATTERNS IN LESS DEVELOPED COUNTRIES AND EMERGING ECONOMIES

76. The literature on openness is concentrated in the developed world. Table 4 shows all papers published on the topic in the database constructed for this project. The affiliations of the authors of the papers were parsed, and those countries were divided into High/Low/Middle income according to the World Bank classification. 97.9% of the authors on these papers are from High-income countries, which illustrates that the literature is also biased towards developed countries. That said, there is relevant work in tangential fields that the report draws upon to make meaningful conclusions (please see Table 4).

77. In many emerging economies, most notably Brazil, Russia, India and China (BRIC), the use of intellectual property by public research institutions and private firms appears to be on the rise. Research on China and India suggest that the number of filed patents in foreign countries (particularly the USPTO) as well as in domestic patent systems by domestic companies have increased rapidly (Bhattacharya et al., 2007; Alnuaimi, Puranam and George, 2011; Alnuaimi, Singh and George, 2011). Foreign filings reflect the underlying trend in increasing worldwide intellectual property filings. The 2011 World Intellectual Property Indicators (WIPI) Report shows an all-time high of 1.98 million patent applications in 2010 (7.2% growth) and 3.66 million copyright filings (11.8% growth).

78. At the same time, companies from developed countries are moving R&D subsidiaries to emerging economies to benefit from low cost human capital and access to country-specific knowledge (e.g. Chung and Alcacer, 2002; Thursby and Thursby, 2006). Some even argue that the quality of inventions (defined as citations received by these patents) produced in the emerging economies is improving. For instance, a matched sample analysis between US firms with subsidiaries in India and China showed that inventions developed in these countries had similar impact as those in the US (Alnuaimi, Singh and George, 2011). This suggests that these countries are becoming credible alternatives to developing inventions with high potential.

79. In the emerging countries, especially those less developed than the BRIC countries, there are still many big challenges with regards to openness and intellectual property. Domestic companies, as well as multinationals seeking to establish presence in those countries, struggle with weak resource endowments and weak institutional regimes. Alnuaimi, Opsahl and George (2010) mapped Indian organizations within the global network of innovators. Despite the scenario for inventors in emerging economies being much more conducive than before, local (indigenous) innovators remain at the periphery of the global innovation network. Using the latest comprehensive data for patents issued (2004), Figure 3 maps the cluster of innovator firms with the three largest Indian innovators (shaded solid black) occupying only peripheral, and less well-connected, positions in the global patent network. These suggest that, in spite of recent popular discussions of shifts in the innovative base eastwards, emerging economies and less developed countries have a significant catch-up phase ahead of them (please see Figure 3).

### 6.1 INNOVATION ECOSYSTEM

80. With growing research capabilities in low and middle income countries, innovation systems are at transitional stage; in many countries foundations exist but are weakly articulated (Arocena and Sutz, 1999; 2001; Gu, 1999). In 2008, low and middle income countries published 23% of the papers (ISI Thomson, Web of Science) and received 1.6% of the patents granted at the USPTO (Figure 4) vis-à-vis 14% and 0.55% respectively in 1998. South East Asia, Eastern Europe and Latin America (IADB, 2010; UNESCO, 2010) registered remarkable trend in the growth of total scientific production whereas the high income countries saw their participation decreased from 86 to 77 percent between 1998 and 2008. In 2008, India and

China were the top publishers in terms of shares in total world publication with 2.7 and 7.9% percent, followed by Brazil (2.1%) and Poland (1.4%) (Zuniga, 2011).

81. Although, appropriate mechanisms of innovation and appropriability exist in low and middle income countries, research capabilities still remain affected by the lack of investment in R&D infrastructure and insufficient availability of human capital. In 2007, R&D investment in developing countries represented 0.35 percent of the Gross Domestic Product (GDP), whereas in developed countries R&D investment represented 2.02 percent of the GDP (Zuniga, 2011). Further, these countries face great difficulties in retaining the talent given the poor employment opportunities and weak annual wages. Constrained access to venture capital and seed funding remains a major barrier in commercialization of the research, particularly access to pre-seed capital, which remains a bottleneck for high technology startups. BRIC countries are an exception where public and private sector R&D investment has substantially increased during the last decade (please see Figure 4).

82. Though many low income countries have articulated policies on innovation, technology transfer and protection of IPRs, the structure of the research system is skewed towards public research institutions with the government performing on average 45% of total R&D (compared to 17 percent in developed countries) (Zuniga, 2011). The government funded research expenditure has largely focused on public good and basic economic needs such as poverty, agriculture and health thus overlooking engineering and industrial research. Existing institutional norms have often undervalued the role of scientific knowledge in firm competitiveness and industry development (Arocena and Sutz, 2001; Intarakummnerd et al., 2002; Govindaraju, 2010); consequently, the interaction between science and industry remains tenuous. Nowadays, many public research institutions and technological institutes face the challenges presented by having an aging staff and retaining young qualified staff, as is the case in countries such as Chile (World Bank, 2009) and Kenya (Flaherty et al., 2010).

83. Perhaps, the largest source of domestic R&D activity remains the multinational corporation. A number of studies have examined the value of cross-country R&D collaboration in the MNC context. For example, Frost and Zhou (2005) found that a larger number of repeated ties between a headquarters and a foreign subsidiary increase the likelihood of reverse knowledge transfer. As such, cross-country collaboration on R&D has been established as a valid mechanism for integrating geographically dispersed knowledge, even if it is complex (Sorenson, Rivkin and Fleming, 2006), and using it towards creating high-impact innovations (Singh, 2008; Lahiri, 2010). In Table 5, Alnuaimi, Singh and George (2011) report the propensities of US MNC firms to collaborate with the subsidiaries to generate patents in the computer hardware industry. Indian and Chinese subsidiaries are the most common, and over half the patents had cross-country collaboration. Such collaboration patterns mark an increasing trend where emerging economies are developing a local talent base and ecosystem that supports a culture for creativity and innovation (please see Table 5).

84. Government research institutions, universities and private sector remain the key institutions driving the R&D activities, but unlike advanced economies the collaboration with industry in R&D is not a frequent practice in developing countries. Public research institutions have played a critical role in the development of industry and other key strategic sectors especially in countries such as India (agriculture), Korea (electronics), Malaysia, China, Brazil (aircraft and agricultural industry) and Singapore. Traditionally, research at government institutions has comprised the bulk of R&D in LDCs, some of which have research institutions with international standards (such as Hong Kong Productivity Centre, Korean Institute of Science and Technology, Indian Institute of Science). These public research institutions are successfully engaged in technical assistance and contributed to strengthening the absorptive capability of local firms through training, quality testing and product development, linking with multinationals, organized R&D consortium and spin-offs and thus can perform the role of coordinator or “fixers” of systemic failures in innovation systems (Intarakumnerd et al., 2002).

85. Unlike research institutions, only few universities conduct research activities in less developed economies. The interaction between university and industry has historically been scarce. In many countries, commercial activities by universities and researchers have been (or still are) highly regulated or forbidden by public sector laws (e.g. Solleiro and Escalante, 2009; Tansinsin, 2007). But the universities in developing economies are undergoing a phase of evolution with a trend towards increasing autonomy in Asian, South American and South African Universities. The universities are integrating innovation skills and industry demands in education programs (Wu, 2010; OECD, 2007), enhancing collaboration with foreign universities, international research institutions and with the industry.

86. According to UNESCO (2009), the public sector funded 100% of R&D in Burkina Faso and 41% in Uganda. In Madagascar, the higher education represents 60% of total funding of R&D in the country. For Thai firms, the innovation survey suggests that 20% of firms surveyed have used the services of any of those PROs or technology institutes. In China (Shanghai survey 2006), although half of firms report some kind of interaction with academia, less than 14% of these firms conducted joint R&D with universities. A 2006 survey of 703 private enterprises in Shanghai shows that among those who have interacted with academia (52.4%), the large majority resorts to technology services contracts (27.5%) and a much smaller number (13.8%) conducts joint R&D with universities (Wu, 2010) (please see Figure 5).

87. Government research institutions have traditionally been the main actors in national research activities with government performing, on average, 45% of total R&D (compared to 17% in developed countries) (Zuniga, 2011). Though, the role of universities is recent it is gaining importance in the R&D of low and middle income countries.

88. The lack of a “business” demand for scientific knowledge has also contributed to the limited use of the outputs of R&D in less developed countries where firms rely on off-the-shelf imported technology from advanced economies mostly in forms of machinery and turn-key technology transfer from abroad (George and Prabhu, 2003; Zuniga, 2011) and often these low income countries are considered imitators or adopters of technologies developed elsewhere. Figure 6 illustrates the allocation of innovation expenditures in which the bulk of technological efforts are concentrated in the acquisition of capital and machinery (associated to innovation) (please see Figure 6).

89. Because LDCs are at different stages of economic development, this presents variation in industry and firm characteristics and heterogeneous levels of technological capacities; leading to very different appropriability dynamics. Yet, the potential benefits of reverse engineering have often led to the erroneous conclusion that developing countries ought to be (or even are) “imitators” of technologies/knowledge from the developed countries rather than “generators” of technologies and knowledge for development. Lopez (2009) further adds that though the less developed countries are mostly dependent on foreign technology sources, domestic innovative activities also exist. The innovation activities go well beyond copying, and they show the existence of a wide range of technological capabilities ranging from the more widespread adaptive and incremental ones, to the more rare but far from negligible “genuine” innovative capabilities. Though examples abound of frugal innovation or reverse innovation, the evidence tends to be less systematic (George, McGahan and Prabhu, 2012).

90. The current understanding of the genuine indigenous innovative capabilities in less developed economies is still limited and thus the understanding of the IPR protection and appropriability mechanisms deployed by firms for such capabilities has remained weak. This situation combined with a lack of absorption capacity in firms and their preference for incremental (or imitative) innovation and acquisition of foreign technology as primary innovation strategies, partially explains the fragmentation in national innovation systems in less developed countries (Navarro et al., 2010; Anllo and Suarez, 2009).

## 6.2 FORMAL AND INFORMAL APPROPRIABILITY MECHANISMS

91. The mechanisms for regulating the ownership of IP rights are very diverse including national laws, innovation laws, contracting laws, regulating R&D systems, and ownership clauses in patent laws and labor laws. Policy frameworks in middle income countries are mirroring international policy trends in the provision of patent rights to research institutions, institutionalizing incentives for researchers, and the promotion of technology transfer infrastructure. In some countries, IP laws provided the starting point for the commercialization of public research when they established the legal rights for universities (employers) and PROs to own and exploit intellectual assets derived from their research activities (Zuniga, 2011; WIPO, 2011, Chapter 4).

92. The few studies that examine relevance of appropriability mechanisms in LDCs suggest that while some empirical facts are similar to those observed in developed countries – e.g. larger firms have higher patent propensities, sectoral factors have an impact on the observed patenting rates – there are other specific factors that need special attention – e.g. the relevance of foreign ownership on appropriability strategies, and the scarce use of strategic appropriability methods (Lopez, 2009).

93. Aside from formal methods of protection such as patents (foreign and domestic patent system), designs, trademarks, utility models and copyright and informal methods used in low and middle income countries include lead time, secrecy, long-term contracts with workforce, suppliers' contracts and exclusive relations with customers. In a study of 120 information technology (IT) firms in India, respondents were asked about the effectiveness of different appropriability mechanisms. Lead times, good marketing and distribution facilities were rated as the most critical followed by brand building. Patents and copyright were considered to be more effective than inimitability due to complexity and secrecy for both product and process innovations. Patents were perceived as more effective for product than for process innovations (Gupta, 2008). Given the rapid growth in formal IP using patents and copyrights to an all-time high in 2010 (WIPO Report, 2011), it is likely that low and middle income countries develop corresponding complementary capabilities, informal methods of protection and new business models to compete in the domestic and global markets.

## 6.3 NEW BUSINESS MODELS, PRIZE COMPETITIONS AND OPEN LICENSING

94. As discussed, weak institutional infrastructure with firm R&D under-investment and limited support for entrepreneurship continues to hamper broad innovation ecosystem development efforts. However, new approaches are emerging to spur relevant local innovation systems. The role of the State and grant-making bodies in inducing innovation and generate novel solutions to "grand challenges" has become popular. To help attract global attention to neglected tropical diseases, such as the Chagas disease or American Trypanosomiasis, countries including Bangladesh, Barbados, Bolivia, and Suriname introduced the concept of a prize fund to encourage technology solutions as differing from new product ideas. High income economies, including the United States, use such prize competitions in emerging areas such as renewable energy storage and advanced materials. The design of these contests needs to account for the uncertainty of the problem – open contests appear to be effective when the problem is complex and outcomes are highly uncertain; whereas a managed competition with limited rivalry promotes optimal outcomes when the problem is less complex and outcome is more certain (Boudreau, Lacetera and Lakhani 2011). Given the emergent popularity of open prize contests in promoting innovation, further systematic evidence is needed to understand how such contests should be designed to help improve their effectiveness and reach.

95. Open prize contests help attract global attention to local or regional problems. Alongside such efforts, some innovations have come about due to technological advances that allow low income countries that do not have an established infrastructure to find creative, new ways to leapfrog similar efforts in high income economies. For instance, collective efforts such as the Ushahidi platform, a non-profit technology company that develops free and open source software for data collection, visualization, and interactive mapping, play a critical role in crowd-sourcing crisis information be it natural disasters or violence become lifesaving interventions originally in Kenya, but now widespread across Africa, South America and Asia. Current applications include Landconnect to track land rights issues in South Africa, the migration crisis in Libya, Sinsai on the eastern Japan earthquake. The simplicity and enabling nature of mobile telephony platform has the power to transform collaborative work applications not just in crisis management, but also to trigger transformative innovations to improve daily life and living conditions. Even when such efforts are started by non-profit or for-profit organizations, governments can serve as primers and promoters of collaborative, open innovation platforms.

96. Other examples of collaborative models include web-based innovation brokerage sites such as Innoget and Innocentive enabling the participation in the generation and exploitation of new ideas from developing countries. Such patterns of innovation are markedly different from often discussed R&D efforts of multinational corporations or public research organizations that enhance the scientific capability base of a country. Instead, these innovations that are variously termed as “frugal innovation” reflect their low cost orientation and the resource-constrained environment in which they were initiated. Lopez (2009) further highlights the importance of incremental and cumulative innovations, which are mostly informal (i.e. without R&D) and developed in the traditional sectors, are, thus, central to the innovative performance of developing countries.

97. Local innovative solutions are now being developed in partnership with governments in public-private partnerships. For example, to bridge the digital divide in primary education, the Government of India developed a partnership program to develop low cost technologies to access the internet. Based on the 2001 census, UNICEF India reports that nearly 115 million children attend primary schools. More than half these children drop out before they reach the eighth grade. In this difficult context, the Government of India along with research institutions and private partners has developed the $35 Sakshat Tablet[3] to bridge the “digital divide” between children with computer and Internet access and those that do not. The $35 tablet has all the functionality required for email, Internet browsing, and video streaming.

98. Government “co-creation” along with private partners has evolved new business models for operating in the low cost innovation space. These public-private partnership (PPP) models of innovation, risk sharing, and regulatory support have made innovation for social purposes possible. For example, “SMS for Life”[4] which provides visibility of anti-malarial stock levels to support more efficient stock management using simple and widely available SMS technology was developed by a collaborative partnership between the Government of Tanzania and private firms.

99. “Social profit” or social welfare can also serve as an incentive for entrepreneurs to invest their time and money in innovation activities. Open software programs (freeware) are developed considering the idea of public or communal property rights. Jaipur knee project[5], the prosthetic leg developed by BMVSS which was designed to be inexpensive, quick to fit and manufacture and to be water-resistant, was developed at a cost of approximately $30.

[3] http://en.wikipedia.org/wiki/Sakshat
[4] http://www.rbm.who.int/psm/smsWhatIsIt.html
[5] http://en.wikipedia.org/wiki/Jaipur_foot

Similarly, Lifestraw is a simple straw that filters water and is widely circulated in Africa where water-borne illnesses are rampant.

100. In the adjacent figure 8, examples of innovations are clustered by size and profit-making goals (please see Figure 8). There are multiple by large, profit-making entities including BP's smokeless stove (Oorja), Novartis' rural health initiative (ArogyaParivar), Nokia's 1100 phone for $20, and Nestle's "popularly positioned products" that include low cost innovations in manufacturing, sourcing, and packaging, which allows the company to provide nutritious food at low cost. Tata Nano, a $2,000 no frills car in which the cost was brought down by dispensing with most nonessential features, reducing the amount of steel used in its construction, and relying on low-cost Indian labor. The Nano car, however, has suffered from lower social acceptance and commercial success than anticipated because of poor product positioning and initial technical problems. Based on the low cost car concept though, other competitors have now revised their product offering with attractively priced cars for the low income market. Chotukool, a $55 refrigerator does not have a compressor, and instead uses a cooling chip and fan similar to those that keep desktop computers from overheating and the number of parts down to around 20 instead of the 200-plus used in conventional refrigerators. Other prominent examples, such as Nestlé's "popularly positioned products", which apply technology to provide nutritional value at a reduced cost and appropriate serving size. These products are often accompanied by a change in business activity to reflect local distribution methods, including street markets, mobile street vendors, and door-to-door distributors. In addition to creating much-needed local jobs, such innovations have improved Nestlé's market penetration, generating worldwide sales of 11 billion Swiss francs in 2010 (Nestlé Research, 2011).

101. The debate on IPRs in developing countries is often focused on whether weak or strong IPRs are more favorable for less developed countries. While lax IPRs are thought to favor imitation, copy and reverse engineering – and hence are seen by some as favorable for deployment of learning processes that could lead in the medium and long run to the creation of genuine innovation capabilities in those countries. It is often stated that strong IPRs are a condition for developing countries to receive updated technology transfers by means of licenses and foreign direct investment (Lopez, 2009), but new business models and low cost innovations provide a parallel avenue for locally honed and developed context-specific innovations that could benefit the western world equally (George, McGahan and Prabhu, 2012). Therefore, a comprehensive view of innovation in low and middle income countries will necessarily be incomplete if we consider only formal models of IP. Instead, as discussed above, new business models, prize competitions, and open sourced ideas provide new avenues to complement innovation ecosystem development efforts in these countries.

## 7. CONCLUSIONS

102. Open and distributed innovation has gained popularity in business practice (Jazairy, 2010) and as a subject of study among academics (Dahlander and Gann, 2010). While there is great interest in open innovation, we sought to move beyond hype to explain what openness entails, what means are available to protect innovations, and how this applies in different initiatives.

103. First, this analytical taxonomy provides a lens for analyzing specific initiatives, with regards to (1) the flow of ideas and resources across organizations and (2) how organizations can protect their innovations from being depleted by someone else. By exploring a range of different initiatives, this analytical taxonomy provides relevant variables for comparative analysis. What emerges is the importance of considering both advantages and disadvantages of each initiative, to understand the opportunities and challenges this poses for government policy-makers, organizations as well as individuals.

104. Second, different types of openness are often combined (Alexy and Dahlander, 2012). This becomes evident when analyzing initiatives. Studies of open innovation thus need to capture different forms of openness. For instance, companies can reveal technologies externally, and they do so to facilitate the general advance in a direction that would benefit the organization. Revealing then is often linked to the ability to source ideas.

105. Third, the applicability of these initiatives varies largely by industry, suggesting there is no "one initiative fits all". An important takeaway is that open innovation may not apply everywhere. In some industries, there is little adoption of these initiatives. Many of the empirical examples are from high tech industries (see e.g. Chesbrough and Crowther, 2006), but there is often less need to go across organizational boundaries when the knowledge frontier is moving slowly. Initiatives vary in their reach. Some initiatives solve a particular problem, such as open licensing that allows for users to cumulatively use, build and improve each other's work. This is only relevant in some industries, such as software and media. Other initiatives are applied more broadly across industries. This is an area that requires much further work, as there is little material that compares open innovation across industries and different nations. It is thus important to be careful in the conclusions.

106. Fourth, the role of intellectual property is changing and it can both impede and aid the innovation process (Alexy et al. 2009; West, 2003). For example, it can *hinder* the innovation process if organizations use the patent system to fend off competition. When organizations patent for strategic reasons patent thickets may emerge that retard the general advance. A number of solutions have been advanced to resolve these situations, such as patent pools. They can *facilitate* the innovation process by providing "rules of the game". IP protection allows organizations to trade information and overcome the "disclosure paradox".

107. Fifth, the Internet has changed, or created new opportunities, for business to connect to individual users. For instance, although platforms and prize competitions are old ideas, they have gained renewed interest with the emergence of the Internet. The Internet has scaled the extent of the market so that scientists, engineers and other skilled people from around the globe could potentially contribute. A new technical infrastructure aids the innovation process and this Innovation Technology can support collaboration among stakeholders. It provides opportunities for these individuals to respond to open requests from organizations, as well as work together to develop new ideas and solutions. A simple categorization was developed for the broad range of different arrangements that exist, separating the type of task being outsourced and identifying whether participants are interacting when taking part.

108. Sixth, although many Internet enabled initiatives have been created to keep intellectual property interests at bay, they use the existing legal frameworks to make this happen. Notably, open source as well as creative commons licenses use copyright law to make sure some rights are waived to the benefit of future creators (Carroll, 2011). Scholars have also begun to consider how lessons from open licensing practices can be adopted to ensure scientific output remains open. Evans and Reimler (2009) suggest that open access promote other scholars to build upon the research, and that this is particularly salient for developing countries. Researchers in these countries work under more severe resource-constraints, and hence benefit more from getting access.

109. Seventh, there is little published research on the implications of open innovation in developing countries. Early research focused on large multinational companies (Chesbrough, 2003), and more recent has elaborated on the implications for smaller companies (see e.g. Lee et al., 2010; Vahter et al., 2012). However, there is almost no research on developing countries, so this report drew on research in tangential field to draw the picture in these countries, as a first attempt. Further research is needed on the role of open innovation in emerging economies, as the evidence to date is limited. Current research, however, suggests that the differences in the use of IP are narrowing between the developed and developing world

(WIPO, 2011). It could be potentially difficult to extrapolate some of the findings from the developed countries to emerging countries. For instance, although Evans and Reimler (2009) suggest that open access is particularly important for emerging economies, this may not be the case for the low-income countries where Internet access is less common. There is some anecdotal evidence that openness can be beneficial, but this should be subject for further research.

## 8. RECOMMENDATIONS

110. A number of recommendations flow from this Taxonomy-Analytical Study for the WIPO Project entitled "Open Collaborative Projects and IP-Based Models". It is believed that these will form a useful basis for consideration and development for the In-Depth Evaluation Study.

A) Requirement for better evidence:

- Quantification of frequency of use of different IP ownership types in various collaborative initiatives;
- Mapping of geographical spread of open collaborative initiatives and the related forms of IP;
- Analysis of variations within and between emerging and high-income countries;
- Development of an evidence base for activities in low-income economies;
- Analysis of barriers to open collaborative innovation projects and the role played by IP;
- Analysis of consequences of Internet-based IP trading and open collaborative marketplaces. E.g. is this leading to a virtual brain drain? Does it skew the development of IP in developing countries to solving first-world problems?

B) Development of collaborative innovation and IP infrastructures

- WIPO could explore the infrastructure and institutional costs of participating in international open collaborative networks;
- WIPO could pilot and promote the development of collaborative innovation technologies as a platforms for open collaborative innovation and engagement across boundaries;
- Development of the role of public data to support and encourage collaboration for innovation, e.g. use of public data in stimulating provisions of new services from which IP may be developed.

*

* *

**LIST OF REFERENCES:**

Acha, V. *Open by Design* (2008). The Role of Design in Open Innovation. *Department for Innovation, Universities & Skills,* London.

Afuah, A. & Tucci, C. (2011). Crowdsourcing as Solution to Distant Search. *Unpublished manuscript*, EPFL and University of Michigan.

Alexy, O., Criscuolo, P. & Salter, A. (2009). Does IP Strategy Have to Cripple Open Innovation? *Sloan Management Review*, 51 (1), 71-77.

Alexy, O., Criscuolo, P. & Salter, A. (forthcoming). No Soliciting: Managing Unsolicited Ideas for R&D. *California Management Review*.

Alexy, O. & Dahlander, L. (forthcoming). *Managing Open Innovation*. In: the Handbook of Innovation Management. Dodgson, M., Gann, D. M., Phillips, N. (Eds), Oxford: Oxford University Press.

Alexy, O. & Henkel, J. (2011). *Intraorganizational Implications of Open Innovation: The Case of Corporate Engagement.* In: *Open Source Software* http://ssrn.com/abstract=988363; retrieved November 3, 2011.

Allen, T. Managing the Flow of Technology (1977). *Technology Transfer and the Dissemination of Technological Information Within the R and D Organization* Cambridge, MA: MIT Press.

Alnuaimi, T., Opsahl, T.& George, G. (2010). Innovating in the Periphery: The Impact of Local and Foreign Inventor Mobility on Innovation in India. Academy of Management conference, Montreal, Canada. *Working Paper*, Imperial College London.

Alnuaimi, T., Puranam, P. & George, G. (2011). *Emerging Economies as Sources of Innovation: Evidence from Semiconductor Patents of Indian and Chinese R&D Subsidiaries of US Firms*. Academy of Management Conference, San Antonio, Texas. Working Paper, Imperial College London.

Alnuaimi, T., Singh, J. & George, G. (2011). *Not with my Own: International Collaboration Patterns and Innovative Capabilities in Foreign Subsidiaries of MNCs*. Workingpaper, Imperial College London.

Anlló, G., & D. Suárez. (2009). Innovación: Algomásque I+D. *Evidencias Ibeoramericanas a partir de las encuestas de innovación: Construyendo las estrategia sempres arias competitivas*. CEPAL-REDES, Buenos Aires, Unpublished.

Arocena, R. & Sutz, J. (1999). *Looking at National Systems of Innovation from the South*, paper presented to the 1999 DRUID Summer Conference on National Innovation Systems, industrial Dynamics and Innovation Policy, June 1999, Aalborg.

Arrow, K. (1962). *Economic Welfare and the Allocation of Resources of Invention*. In: Nelson, R. (Ed.), The Rate and Direction of Inventive Activity: Economic and Social Factors. National Bureau of Economic Research. Princeton University Press, Princeton, 609-625.

Arthur, B. W. (1989). Competing Technologies, Increasing Returns, and Lock-in by Historical Events. *The Economic Journal*, 99, 116-131.

Arundel, A. (2001). The Relative Effectiveness of Patents and Secrecy for Appropriation. *Research Policy*, 30 (4), 611-624.

Bhattacharya, S., Garg, K., Sharma, S. & Dutt, B. (2007). Indian Patenting Activity in International and Domestic Patent System: Contemporary Scenario. *Current Science,* 92, 1366-1396.

Bloemsaat, B. & Kleve, P. (2009). Creative Commons: A Business Model for Products Nobody Wants to Buy. *International Review of Law, Computers & Technology*, 23 (3), 237-249.

Boudreau, K., Lacetera, N. & Lakhani, K. (2011). Incentives and Problem Uncertainty in Innovation Contests: An Empirical Analysis. *Management Science*, 57 (5), 843-863.

Bradner, S. The Internet Engineering Task Force (1999). Chapter in: Open Sources: Voices from the Open Source Revolution; DiBona, C., Ockman, S. & Stone, M. (Eds.). Sebastopol, CA.

Brunt, L., Lerner, J. & Nicholas, T. (2008). *Inducement Prizes and Innovation*. CEPR Discussion Paper No. DP6917. Retrieved 28 March 2012 from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1307507##.

Carroll, M. W. Why Full Open Access Matters (2011). *PLoSBiol*, 9 (11).

Chesbrough, H. & Rosenbloom, R. S. (2002). The Role of the Business Model in Capturing Value from Innovation: Evidence from Xerox Corporation's Technology Spin-off Companies. *Industrial and Corporate Change*, 11 (3), 529-555.

Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, MA: Harvard Business School Press.

Chesbrough, H. (2006a). *New Puzzles and New Findings*, in: H. Chesbrough, W. Vanhaverbeke, J. West (Eds), Open Innovation: Researching a New Paradigm. Oxford: Oxford University Press.

Chesbrough, H. (2006b). *Open Business Models: How to Thrive in the New Innovation Landscape*. Boston, MA: Harvard Business School Press.

Chesbrough, H. & Appleyard, M. M. (2007). Open Innovation and Strategy. *California Management Review*, 50 (1), 57-76.

Chesbrough, H. & Crowther, A. K. (2006). Beyond High Tech: Early Adopters of Open Innovation in Other Industries. *R&D Management*, 36 (3), 229-236.

Chesbrough, H., Vanhaverbeke, W. & West, J. (Eds). (2006a). *Open Innovation: Researching a New Paradigm*. Oxford: Oxford University Press.

Christensen, J. F., Olesen, M. H. & Kjær, J. S. (2005). The Industrial Dynamics of Open Innovation: Evidence from the Transformation of Consumer Electronics. *Research Policy*, 34 (10), 1533-1549.

Chung, W., Alcácer, J. (2002). Knowledge Seeking and Location Choice of Foreign Direct Investment in the United States. *Management Science*, 48 (12), 1534-1554.

Cohen, W. M. & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35 (1), 128-152.

Cosh, A. & J. J. Zhang. (2011). *Open Innovation Choices – What is British Enterprise Doing?* Cambridge, MA: Centre for Business Research and UK~IRC, University of Cambridge.

Dahlander, L. (2007). Penguin in a New Suit: A Tale of How de Novo Entrants Emerged to Harness Free and Open Source Software Communities. *Industrial and Corporate Change,* 16 (5), 913-943.

Dahlander, L. & Gann, D. M. (2010). How Open is Innovation? *Research Policy,* 39, 699-709.

Dahlander, L. & Magnusson, M. (2005). Relationships between Open Source Software Companies and Communities: Observations from Nordic Firms. *Research Policy,* 34 (4), 481-493.

Dahlander, L. & Magnusson, M. (2008). How Do Firms Make Use of Communities? *Long Range Planning,* 41, 629-649.

Dahlander, L. & O'Mahony, S. (2011). Progressing to the Center: Coordinating Project Work. *Organization Science,* 22 (4), 961-979.

Day, J. S. (1956). *Subcontracting Policy in the Airframe Industry*. Graduate School of Business Administration, Harvard University, Boston, MA.

Dodgson, M., Gann, D. M. & Salter, A. (2005). *Think Play Do: Technology, Innovation and Organization.* Oxford: Oxford University Press.

Dodgson, M., Gann, D. M. & Salter, A. (2006). The Role of Technology in the Shift towards Open Innovation: The Case of Procter and Gamble. *R&D Management,* 36 (3).

Dodgson M., Gann, D. M. & Salter A. (2007). In Case of Fire Please Use the Elevator: Simulation Technology and Organization in Fire Engineering. *Organization Science*, 18 (5), 849-864.

Evans, J. & Reimler, J. Open Access and Global Participation in Science (2009). *Science,* 323, 1025.

Fernando, R. S Understanding Judicial Patent Enforcement in China (2008). China Patents and Trademarks 2 (24).

Fey, C. & Birkinshaw, J. (2005). External Sources of Knowledge, Governance Mode and R&D Performance. *Journal of Management*, 31 (4), 597-621.

Fitzgerald, A. M., Hooper, N. & Fitzgerald, B. F. (2010). *The Use of Creative Commons Licensing to Enable Open Access to Public Sector Information and Publicly Funded Research Results: An Overview of Recent Australian Developments*. In: Bourcier, D., Casanovas, P., Dulong de Rosnay, M. & Maracke, C. (Eds.) Intelligent Multimedia: Managing Creative Works in a Digital World. Florence, ITA: European Press Academia.

Flaherty, K., Murithi, F., Mulinge, W. & Njuguna, E. (2010). Kenya – Recent Developments in Public Agricultural Research. Agricultural Science and Technology Indicators. Kenya Agricultural Research Institute (KARI), *Country Note*, June 2010.

Foong, C. (2010). Sharing with Creative Commons: A Business Model for Content Creators. *Platform: Journal of Media and Communication*, 64-93.

Freeman, C. (1974). *The Economics of Industrial Innovation*. London: Pinter.

Frost, T. & Zhou, C. (2005). R&D Co-Practice and "Reverse" Knowledge Integration in Multinational Firms. *Journal of International Business Studies*, 36(6), 676-697.

Fosfuri, A. 2006. The licensing dilemma: Understanding the determinants of the rate of technology licensing. *Strategic Management Journal*, 27 (12), 1141-1158.

Gallini, N. T. (2002). The Economics of Patents: Lessons from Recent US Patent Reform. *Journal of Economic Perspectives*, 16 (2), 131.

Gambardella, A., Giuri, P. & Luzzi, A. (2007). The Market for Patents in Europe. *Research Policy*, 36 (8), 1163-1183.

Gann, D. M. (2005). Book Review of H. Chesbrough, Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard Business School Press, 2003 (272 pp., ISBN: 1-57851-837-7). *Research Policy*, 34 (1), 122-123.

Gassmann, O. & Enkel, E. (2006). *Towards a Theory of Open Innovation: Three Core Process Archetypes*. R&D Management Conference (2006).

Gassmann, O. 2006. Opening up the innovation process: Towards an agenda. R&D Management, 36 (3), 223-228."

George, G. & Prabhu, G. N. (2003). Developmental Financial Institutions as Technology Policy Instruments: Implications for Innovation and Entrepreneurship in Emerging Economies, *Research Policy*, 32, 89-108.

George, G., McGahan, A. M. & Prabhu, J. C. (2012). Innovation for Inclusive Growth: Towards a Theoretical Framework and Research Agenda. *Journal of Management Studies*, 49 (4).

Govindaraju, C. V. G. R. (2010). R&D Commercialization Challenges for Developing Countries – The Case of Malaysia. V. G. R. *Tech Monitor*, Dec. 2010, 25-30.

Gu, S. (1999). *China's Industrial Technology, Market Reform and Organizational Change*. London: Routledge. .

Guadamuz González, A. (2006). Open Science: Open Source Licenses in Scientific Research. *North Carolina Journal of Law and Technology*, 7 (2), 321-366.

Gupta, V. K. (2008). Indian Patent Output 1990-2007. India, Science and Technology: 2008. S&T Output and Patents. NISTADS: National Institute of Science, Technology and Development Studies, New Delhi, India.

Hall, B. H. & Ziedonis, R. H. (2001). The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-95. *Rand Journal of Economics*, 32 (1), 101-128.

Hargreaves, I. (2011). *Digital Opportunity: A Review of IP and Growth*. UK: Intellectual Property Office.

Harhoff, D., Henkel, J. & von Hippel, E. (2003). Profiting from Voluntary Information Spillovers: How Users Benefit by Freely Revealing their Innovations. *Research Policy*, 32 (10), 1753-1769.

Hardin, R. (1982). *Collective Action*. Baltimore: John Hopkins University Press.

Heller, M. A. & Eisenberg, R. S. (1998). Can Patents Deter Innovation? The Anticommons in Biomedical Research. *Science*, 280, 698-701.

Henkel, J. (2006). Selective Revealing in Open Innovation Processes: The Case of Embedded Linux. *Research Policy*, 35 (7), 953-969.

Huston, L.L. and Sakkab, N.N. 2006. Connect and develop. *Harvard Business Review*, 84 (3), 58.

Hurmelinna, P. and K. Puumalainen. 2007. Nature and Dynamics of Appropriability: Strategies for Appropriating Returns on Innovation, *R&D Management*, Vol. 37, N. 2.

Higgins J. P. T. & Green, S. (editors) (2006). *Cochrane Handbook for Systematic Reviews of Interventions 4.2.6.* In: The Cochrane Library, Issue 4, 2006. Chichester, UK: John Wiley & Sons, Ltd.

Intarakumnerd, P., Chairatana, P. & Tangchitpiboon, T. (2002). National Innovation Systems in Less Successful Developing Countries: the Case of Thailand. *Research Policy*, 31, 1445-1457.

Jaffe, A. B. & Lerner, J. (2006). *Innovation and its Discontents: How our Broken Patent System is endangering Innovation and Progress, and What to do about it.* New Haven: Princeton University Press.

Jazairy, Ali (2010). Open Innovation: Collective Solutions for Tomorrow. WIPO Magazine No. 3, pp. 4-6.

Jeppesen, L. B. & Lakhani, K. R. (2010). Marginality and Problem-Solving Effectiveness in Broadcast Search. *Organization Science*, 21 (5), 1016-1033.

Katz, M. L. & Shapiro, C. (1986). Technology Adoption in the Presence of Network Externalities. *Journal of Political Economy*, 94 (4), 822-841.

KEI (2008). Selected Innovation Prizes and Reward Programs. KEI Research Note 2008:1

Lahiri, N. (2010). Geographic Distribution of R&D Activity: How Does it Affect Innovation Quality? *Academy of Management Journal*, 53 (5), 1194-1209.

Lakhani, K. R., Jeppesen, L. B., Lohse, P. A. & Panetta, J. A. (2006). *The Value of Openness in Scientific Problem Solving*. HBS Working Paper Number: 07-050. Harvard Business School.

Lanjouw, J. & Schankermann, M. (2004). Patent Quality and Research Productivity: Measuring Innovation with Multiple Indicators. *The Economic Journal,* 114 (495), 441-465.

Laursen, K. & Salter, A. J. (2004). Searching High and Low: What Types of Firms Use Universities as a Source of Innovation? *Research Policy*, 33 (8), 1201-1215.

Laursen, K. & Salter, A. J. (2006). Open for Innovation: The Role of Openness in Explaining Innovation Performance among UK Manufacturing Firms. *Strategic Management Journal*, 27, 131-150.

Leiponen, A. and Helfat, C.E. 2005. Innovation objectives, knowledge sources and the benefits of breadth. *Working Paper*, Cornell University, Ithaca.

Lichtenthaler, U. 2005. External commercialization of knowledge.International *Journal of Management Reviews*, 7 (4), 231-255.

Lichtenthaler, U. and Ernst, H. 2009. Technology licensing strategies: The interaction of process and content characteristics. *Strategic Organization*, 7 (2), 183-221.

Lichtenthaler, U. and Ernst, H. 2007. External technology commercialization in large firms: Results of a quantitative benchmarking study. *R&D Management*, 37 (5), 383-397.

Lee, S., Park, G., Yoon, B. & Park, J. (2010). Open Innovation in SMEs: An Intermediated Network Model. *Research Policy*, 39, 290-300.

Lerner, J. & Tirole, J. (2002). Some Simple Economics of Open Source. *Journal of Industrial Economics*, 52, 197-234.

Levin, R. C., Klevorick, A. K., Nelson, R. R.& Winter, S. G. (1987). Appropriating the Returns from Industrial Research and Development. Brookings Papers on Economic Activity, 3, 783-831.

Lieberman, M. B. & Montgomery, D. B. (1988). First Mover Advantages. *Strategic Management Journal*, 9, 41-58.

Liebeskind, J. P. (1996). Knowledge, Strategy, and the Theory of the Firm. *Strategic Management Journal*, 17, 93-107.

Lopez, A. (2009). Innovation and Appropriability, Empirical Evidence and Research Agenda. WIPO International 2009, retrieved 28 March 2012 from

http://www.wipo.int/ip-development/en/economics/index.html
Love, J. & Hubbard T. (2005), Paying for Public Goods, In *Code: Collaborative Ownership and the Digital Economy*, Ed. Ghosh, R.A., (MIT Press, Cambridge, pp. 207-229).
Love, J. & Hubbard T. (2008), Prizes for Innovation in New Medecines and Vaccines, *Perspectives on Patents and Patients: Can they Co-Exist?* In Proceedings of the Loyola University Chicago School of Law's Second Annual Beazley Symposium on Access to Health Care, Chicago.
Mansfield, E. (1986). Patents and Innovation: An Empirical Study. *Management Science*, 32 (2), 173-181.
Menon, T. & Pfeffer, J. (2003). Valuing Internal vs. External Knowledge: Explaining the Preference for Outsiders. *Management Science*, 49 (4), 497-513.
Murray, F. and O'Mahony S. 2007. Exploring the foundations of cumulative innovation: Implications for organization science. *Organization Science*, 18 (6), 1006-1021.
Mowery, D. C. & Simcoe, T. (2002). Is the Internet a US invention? : An Economic and Technological History of Computer Networking. *Research Policy,* 31, 1369-1387.
Navarro, J. C., Llisterri, J. & Zuniga, P. (2010). *The Importance of Ideas for Innovation and Productivity*. Chapter 10 in: The Age of Productivity: Transforming Economies from the Bottom Up; Pages, C. (Editor). Development in the Americas 2010, Inter-American Development, Washington, D. C. Pallgrave, Macmillan.
Nelson, R. & Winter, S. (1982). *An Evolutionary Theory of Economic Change*. Cambridge: Harvard University Press.
Nestlé Research (2011). Popularly Positioned Products: Affordable and Nutritious. Renens: Nestec SA.
Newell, R. G. & Wilson, N. E. (2005). *Technology Prizes for Climate Change Mitigation*. Discussion Paper, Washington, DC: Resources for the Future.
Nuvolari, A. (2004). Collective Invention during the British Industrial Revolution: The Case of the Cornish Pumping Engine. *Cambridge Journal of Economics*, 28, 347-363.
OECD (2007). OECD Review of Innovation: China. OECD: Paris, 2007.
OECD (2008). Open Innovation in Global Networks. OECD: Paris.
Olsen, M. (1967). *The Logic of Collective Action*. Cambridge, MA: Harvard University Press.
O'Mahony, S. (2002). *Community Managed Software Projects: The Emergence of a New Commercial Actor*. Unpublished dissertation, Stanford University.
O'Mahony, S. & Bechky, B. (2008). Boundary Organizations: Enabling Collaboration among Unexpected Allies. *Administrative Science Quarterly*, 53, 422-459.
Ostrom, E., (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, MA: Cambridge University Press.
Owen-Smith, J. & Powell, W. W. Careers and Contradictions: Faculty Responses to the Transformation of Knowledge and its Uses in the Life Sciences*. Research in the Sociology of Work*, 10, 109-40.
Piore, M J. & Sabel, C. (1984). *The Second Industrial Divide*. Basic BooksSchilling, M.A. (2009). Understanding the Alliance Data. *Strategic Management Journal*, 30, 233-260.
Rivette, K. and Kline, D. (2000). Rembrandts in the Attic: Unlocking the Hidden Value of Patents. *Harvard Business School P*ress, Boston (MA).
Rothwell, R., Freeman, C., Horseley, A., Jervis, V.T.P. and Townsend, J. (1974). Sappho Updated - Project Sappho Phase II. *Research Policy*, 3, 204-225.
Rothwell, R. (1994).Towards the fifth-generation innovation process. International Marketing Review, 11(1), 7-31.
Ryan, M. P. (2010). Patent Incentives, Technology Markets, and Public–Private Bio-Medical Innovation Networks in Brazil. *World Development*, Vol. 38, No. 8, pp. 1082–1093.
Schumpeter, J. A. (1942). *Capitalism, Socialism, and Democracy*. New York: Harper & Row.
Scotchmer, S. (1991). Standing on the Shoulders of Giants: Cumulative Research and the Patent Law. *Journal of Economic Perspectives*, 5, 29-41.

Shanghai Chamber of Commerce. (2006). *The Private Economy in Shanghai*. Shanghai: Shanghai University of Finance Press.

Shapiro, C. (2001). *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*. Innovation Policy and the Economy, Volume 1. Boston: MIT Press.

Singh, J. (2008). Distributed R&D, Cross-Regional Knowledge Integration and Quality of Innovative Output. *Research Policy*, 37 (1), 77-96.

Sorenson, O., Rivkin, J. W. & Fleming, L. (2006). Complexity, Networks and Knowledge Flow. *Research Policy*, 35 (7), 994-1017.

Solleiro Rebolledo, J. L. & Escalante, F. (2009). *Knowledge Management and Value Creation in Latin American Research Centers – Final Report* – Centro de Ciencias Aplicadas y DesarrolloTecnológico (CCADET), UNAM, Mimeo.

Tansinsin, L. (2007). Development of University – Industry Partnerships for the Promotion of Innovation and Transfer of Technology: Philippines.

Teece, D. J. (1986). Profiting from Technological Innovation: Implications for Integration Collaboration, Licensing and Public Policy. *Research Policy*, 15, 285-305.

Tushman, M. L. (1977). Special Boundary Roles in the Innovation Process. *Administrative Science Quarterly*, 22, 587-605.

Thursby, J. & Thursby M. (2006). *Here or There? A Survey of Factors in Multinational R&D Location and IP Protection*. Washington, DC: Ewing Marion Kauffman Foundation.

UNESCO (2009). *Mapping Research Systems in Developing Countries – Country Review Template* – UNESCO, Paris. Electronic document available at: http://unesdoc.unesco.org/images/0018/001833/183365e.pdf

UNESCO (2009) Mapping research systems in developing countries-Country review template-. UNESCO, Paris. Electronic document available at: http://unesdoc.unesco.org/images/0018/001833/183365e.pdf

Vahter, P., Love, J. H. & Roper, S. (2012). *Openness and Innovation Performance: Are Small Firms Different?* Working Paper No. 113, Warwich Business School.

van de Vrande, V., de Jong, J. P. J., Vanhaverbeke, W. & deRochemont, M. (2009). Open Innovation in SMEs: Trends, Motives and Management Challenges. *Technovation*, 29, 423-437.

van de Vrande, V., Lemmens, C. and Vanhaverbeke, W. (2006). Choosing governance modes for external technology sourcing. *R&D Management*, 36 (3), 347-363.

von Hippel, E. (1988). *The Sources of Innovation*. New York: Oxford University Press.

von Hippel, E. (2005). *Democratizing Innovation*. Cambridge, MA: The MIT Press.

von Hippel, E. & von Krogh, G. (2003). Open Source Software and the Private-Collective Innovation Model: Issues for Organization Science. *Organization Science*, 14 (2), 209-223.

von Krogh, G., Haefliger, S., Spaeth, S. & Wallin, M. W. (Forthcoming). Carrots and Rainbows: Motivation and Social Practice in Open Source Software Development. *MIS Quarterly, 1-68*.

von Zedtwitz, M. & Gassmann, O. (2002). Market Versus Technology Driven in R&D Internationalisation: Four Different Patterns of Managing Research and Development. *Research Policy*, 31 (4), 569-588.

West, J. (2003). How Open is Open Enough? Melding Proprietary and Open Source Platform Strategies. *Research Policy*, 32, 1259-1285.

West, J., Vanhaverbeke, W., Chesbrough, H. (2006). Open innovation: A research agenda. in: H. Chesbrough, W. Vanhaverbeke, J. West (Eds), Open Innovation: Researching a New Paradigm. *Oxford University Press*, Oxford.

WIPO (2011). *World Intellectual Property Report 2011: The Changing Face of Innovation*. Geneva: World Intellectual Property Organization.

World Bank (2009). *Chile: Fostering Technology Transfer and Commercialization*, Washington, D. C: The World Bank.

Wu, W. (2010). Managing and Incentivizing Research Commercialization in Chinese Universities. *Journal of Technology Transfer*, 35, 203-224.

Zahra, S. A. & George, G. (2002). Absorptive Capacity: A Review, Reconceptualization and Extension. *Academy of Management Review*, 27 (2), 185-203.

Zuniga, P. (2011). *The State of Patenting at Research Institutions in Developing Countries: Policy Approaches and Practices*. Background Report to the Publication: Intellectual Property and the New Innovation Paradigms. Washington D.C.

## LIST OF TABLES:

**Table 1: Different types of openness**

| | Inbound innovation | Outbound innovation |
|---|---|---|
| **Pecuniary** | **Acquiring**<br>Acquiring inventions and input to the innovative process through informal and formal relationships (e.g. Chesbrough and Crowther, 2006; Christensen et al., 2005) | **Selling/Licensing**<br>Out-licensing or selling products in the marketplace (e.g. Chesbrough and Rosenbloom, 2002) |
| **Non-pecuniary** | **Sourcing**<br>Sourcing external ideas and knowledge from suppliers, customers, competitors, consultants, universities, public research organizations, etc. (e.g. Fey and Birkinshaw, 2005; Lakhani et al., 2006; Laursen and Salter, 2006a) | **Revealing**<br>Revealing internal resources to the external environment (e.g. Allen, 1983; Henkel, 2006; Nuvolari, 2004; von Hippel and von Krogh, 2003) |

*Source*: Dahlander and Gann (2010)

**Table 2: Categorization of different types of Internet-enabled initiatives**

| | **External people disconnected** | **External people connected** |
|---|---|---|
| **Finding solutions to problems**<br>Well-defined question where solutions can be evaluated | Innocentive<br>Amazon Mechanical Turk | Facebook translations |
| **Aggregating preferences**<br>Selecting between options where outsiders express opinions or trade | Yelp | Trading between people among options |
| **Developing new solutions to undefined problems**<br>Undefined problem where outsiders develop new solutions or ideas evaluation criteria is uncertain | UserVoice | Open source<br>Wikipedia |

*Note*: Many initiatives combine elements listed above. For instance, Threadless use the community to develop new design for T-shirts, but also allow the community to vote on those designs to select the designs to print.
*Source*: This report.

**Table 3a: Analysis of initiatives**

| | **Initiatives that facilitate flow of knowledge between companies** | | | |
|---|---|---|---|---|
| **Type of challenge** | **Allow for organization to exchange and trade knowledge** | | | |
| **Initiative** | **Licensing** | **Sub-contracting** | **R&D alliance** | **Joint ventures** |
| **Focus** | License that stipulate rules of use to a licensee in exchange for financial compensation. | Agreement to an external partner to conduct a specific task. | A formal relationship between two or more parties to pursue joint research activities that allow them to share and develop new knowledge. | Two organizations create a jointly owned legal entity to develop a new service or product. |
| **Form of openness** | Establish trading of already existing knowledge from parties.<br><br>Means of acquiring or selling knowledge to outside organizations. | Outsource the creation of knowledge to external party.<br><br>Means of acquire or selling a task to an outside organization. | Collectively develop knowledge with external party.<br><br>Means of establish a formal relationship to reveal and source ideas from an outside organization. | Establish formal organization to collectively develop knowledge with external party.<br><br>Means of establish a new unit so as to source ideas from outside organizations. |
| **Means of appropriability (role of IPRs and other forms)** | IPRs facilitate trade and overcome the "disclosure paradox".<br><br>Patents and copyright important to facilitate trade of knowledge and information. | The contract specifies the task and that the contractor gains the IPRs<br><br>Patents and copyright of medium importance. Companies usually pursue this strategy to outsource non-strategic parts of the innovation process. | Contract typically specifies what happens with inventions that are developed from the alliance (foreground IP).<br><br>It is specified what will happen with intellectual property rights *a priori*. Companies enter alliances to get access to information and knowledge they do no possess. | IPRs belong to the joint venture, allowing the owners to trade knowledge. |
| **Potential positive and negative consequences** | + Promote the exchange of knowledge<br>- Promote a patent race to have a portfolio of patents to work as bargaining power (patent thicket) (WIPO 2011, chapter 2 elaborates further) | +Overcome internal resource constraints<br>- Monitoring problems and risk of losing access to key technologies | + Overcome internal resource constraints<br>+ Flexibility<br>- Increased coordination costs<br>- Ownership ambiguity | + Share gains and losses with other organizations<br>- Greater reliance on external actors |

*Source*: This report.

## Table 3b: Analysis of initiatives

| **Type of initiative** | **Initiatives that resolve ambiguity of ownership between companies** | | | |
|---|---|---|---|---|
| **Type of challenge** | **Allow for organization to use knowledge, when much of the knowledge is being protected by IPRs** | | | |
| **Initiative** | **Cross-licensing** | **Patent pools** | **Defensive patent pools** | **Open standards** |
| **Focus** | Cross-licensing agreements refer to when two or more parties grant a license to one another for the right to use certain patents, copyright or trademarks that each owns. | A consortium of two or more companies that agree to cross-license patents in a technological area. | One or more patent holder's cross-license their patents and pledge they will not be used to sue for infringement. | An open standard is a standard that is publicly available and has various rights to use associated with it. |
| **Form of openness** | Establish ways to build upon each others knowledge where patents previously locked organizations.<br><br>Means of establishing a playing field for using one another's creative work. | Establish ways to build upon each others knowledge where patents previously locked organizations<br><br>Means of establishing a playing field for using one another's patents. | Defensively publish to enable the cumulative advance in a technological area.<br><br>Means of revealing to facilitate the cumulative advance, and increase opportunities to source information in the future. | Promote a standard by establishing common rules. Anyone can typically contribute and use the technology. |
| **Means of appropriability (role of IPRs and other forms)** | License the right to use of technologies.<br><br>Patents or copyrights that were previously blocking parties can then be used without risking legal consequences. | When multiple parties are blocking one another or when various patents are required to commercialize one technology, patent pools can increase the freedom for organizations, yet maintain competition in the product market.<br><br>Patents that were previously blocking parties can then be used without risking legal consequences. | Certain patents are contributed to the patent pool that pledges they will not be used in court.<br><br>Patents do not offer protection, but are essential in making this solution emerge. Companies instead put greater emphasis on complementary assets and gaining first mover advantages. | Dictate "reasonable and non-discriminatory" royalty fees and other licensing terms. |
| **Potential positive and negative consequences** | + Clear blocking of technologies and allow companies to use existing technologies<br>- Raise potential anti-trust concerns | + The pool allows the licensee to know what they license without worrying about complementary rights<br>+ Clear blocking of technologies<br>+ Works well if technologies are complements<br>- Potentially anti-competitive if technologies in the pool are non-infringing substitutes | + More organizations and individuals are willing to contribute so facilitate the general advance<br>- Skeptics claim companies are not contributing with key patents<br>- Those organizations that contribute to the pool are often not the potential organizations to sue | + Promote collaboration between companies in the development of the new technology<br>+ Allow competition between companies within the open standard<br>- Companies often try to game the system by keeping key technologies theirs, and everything else open |
| **Empirical examples** | Mobile device – such as the recent example between Microsoft and Samsung | MPEG-2 | Open Invention Network | Internet Engineering Task Force |

*Source*: This report.

## Table 3c: Analysis of initiatives

| **Type of initiative** | **Initiatives that facilitate innovation between companies and users** | | |
|---|---|---|---|
| **Type of challenge** | **Allow for organizations to interact with users and facilitate conditions that are mutually beneficial** | | |
| **Initiative** | **Idea competitions and prizes** | **Open licensing** | **Boundary organizations** |
| **Focus** | Reveal problems to be solved and distribute to a pool of potential solvers. Two different types – targeted and blue-sky. | Use copyright law to modify this to enable that some rights are waived for the benefit of future creators. | Establish a not-for-profit organization that can resolve ambiguity about ownership and control. |
| **Form of openness** | Facilitate matching of organizations facing known or unknown problems, and potential solvers of those problems.<br><br>Means of acquiring solutions from external actors. Allow matching between a large set of individuals. | Waive rights to facilitate flexibility for future creators and inventors. Allow for gradual improvements, while still giving recognition to the original creator.<br><br>Means of revealing internal information to facilitate the cumulative advance. | Create a new legal entity to facilitate interactions between companies and individual users. Establish a ground for what is allowed.<br><br>Means of establishing a common organization that can resolve conflict that may emerge. |
| **Means of appropriability (role of IPRs and other forms)** | Establish an intermediary that connects seekers and solvers of problems. Non-disclosure of solutions to externals.<br><br>Patents provide opportunities to trade, but are not a prerequisite. Most idea competitions have detailed instructions for who will own the idea, when ownership will be transferred, and what happens with those solutions that are not used. | Use available copyright law but modifies it to make sure certain rights are waived. The exact rights that are waived vary across projects.<br><br>Copyright does not offer protection, but are essential in making this solution emerge. Companies put greater emphasis on complementary assets and first mover advantages as means of protection. | Establish an organization that can represent all involved parties. This organization specifies how knowledge can be used so that potential partners with different interests can interact. |
| **Potential positive and negative consequences** | + Benefit from distributing problems to a large and diverse pool of solvers maximize the likelihood of findings new solutions<br>- Attention problems may surface – too much to choose from | + Allow for recombination and extension of work.<br>- Many different licenses to understand<br>- Organizations must understand how and when licenses can be combined | + Promote collaboration between actors with different underlying interests<br>- Takes time to build trust<br>- Difficulty in founding shared interests |
| **Empirical examples** | InnocentiveMathworks<br>Netflix competition<br>Threadless | Wikipedia<br>Creative Commons<br>Open source licenses (there exist hundreds of variants) | Wikipedia<br>Open source communities |

*Source*: This report.

**Table 4: Distribution of countries for the authors of the open innovation publications**

| Country | Freq. | High income | Middle income | Low income |
|---|---|---|---|---|
| USA | 170 | 26.7 | | |
| Germany | 79 | 12.4 | | |
| Italy | 41 | 6.4 | | |
| England | 40 | 6.3 | | |
| Switzerland | 36 | 5.7 | | |
| Netherlands | 35 | 5.5 | | |
| Belgium | 31 | 4.9 | | |
| Canada | 24 | 3.8 | | |
| Spain | 23 | 3.6 | | |
| Korea | 22 | 3.5 | | |
| Denmark | 21 | 3.3 | | |
| Sweden | 20 | 3.1 | | |
| Ireland | 13 | 2.0 | | |
| Austria | 12 | 1.9 | | |
| France | 11 | 1.7 | | |
| Norway | 10 | 1.6 | | |
| Australia | 7 | 1.1 | | |
| China | 7 | | 1.1 | |
| Finland | 7 | 1.1 | | |
| Japan | 6 | 0.9 | | |
| Taiwan Province of China | 4 | 0.6 | | |
| Singapore | 3 | 0.5 | | |
| Portugal | 2 | 0.3 | | |
| Scotland | 2 | 0.3 | | |
| Wales | 2 | 0.3 | | |
| South Africa | 1 | | 0.2 | |
| Brazil | 1 | | 0.2 | |
| Chile | 1 | | 0.2 | |
| Estonia | 1 | 0.2 | | |
| Israel | 1 | 0.2 | | |
| San Marino | 1 | 0.2 | | |
| Mexico | 1 | | 0.2 | |
| Slovenia | 1 | 0.2 | | |
| Uganda | 1 | | | 0.2 |
| | **637** | **97.9** | **1.9** | **0.2** |

*Note*: This table shows raw scores unweighted by the number of authors on the paper by income category. The average team size of the publications is 637/352=1.81. This table is categorized after the World Bank classification. Taiwan, Province of China, is not coded as an independent sovereign nation in the World Bank income classification.
*Source*: This report.

## Table 5: Patenting trend by foreign subsidiaries of US semiconductor MNCs[6]

Patenting trends by foreign subsidiaries of US semiconductor MNCs

| Emerging Economies | | | | Advanced Economies | | | |
|---|---|---|---|---|---|---|---|
| | Subsidiaries | Patents | % Cross-country | | Subsidiaries | Patents | % Cross-country |
| India | 34 | 1158 | 51% | Japan | 65 | 5013 | 20% |
| China | 38 | 260 | 61% | France | 58 | 3518 | 24% |
| Philippines | 7 | 155 | 54% | UK | 101 | 3145 | 33% |
| Russia | 10 | 115 | 67% | Germany | 82 | 2995 | 35% |
| Hungary | 1 | 86 | 34% | Israel | 48 | 2090 | 34% |
| Thailand | 7 | 70 | 29% | Canada | 74 | 1887 | 43% |
| Czech Rep. | 8 | 53 | 55% | Switzerland | 30 | 826 | 50% |
| Brazil | 8 | 39 | 72% | Netherlands | 37 | 758 | 54% |
| Mexico | 11 | 37 | 62% | Singapore | 39 | 656 | 39% |
| Poland | 4 | 35 | 49% | Italy | 37 | 628 | 40% |
| Turkey | 5 | 31 | 97% | Taiwan | 49 | 490 | 42% |
| Ukraine | 4 | 26 | 62% | Malaysia | 22 | 476 | 39% |
| Argentina | 7 | 22 | 73% | S. Korea | 24 | 405 | 43% |
| Romania | 5 | 19 | 89% | Ireland | 25 | 367 | 37% |
| Egypt | 5 | 14 | 64% | Belgium | 24 | 249 | 71% |
| | | | | Denmark | 15 | 206 | 39% |
| | | | | Australia | 22 | 204 | 53% |
| | | | | Sweden | 21 | 149 | 50% |
| | | | | Spain | 14 | 130 | 61% |
| | | | | Hong Kong | 23 | 101 | 60% |
| | | | | Norway | 12 | 93 | 60% |
| | | | | Iceland | 6 | 54 | 54% |
| | | | | New | 10 | 45 | 56% |
| | | | | Austria | 10 | 40 | 65% |
| | | | | Finland | 13 | 38 | 47% |
| | | | | Greece | 5 | 15 | 93% |
| | | | | UAE | 2 | 10 | 100% |

Patenting trends by foreign subsidiaries of US semiconductor MNCs

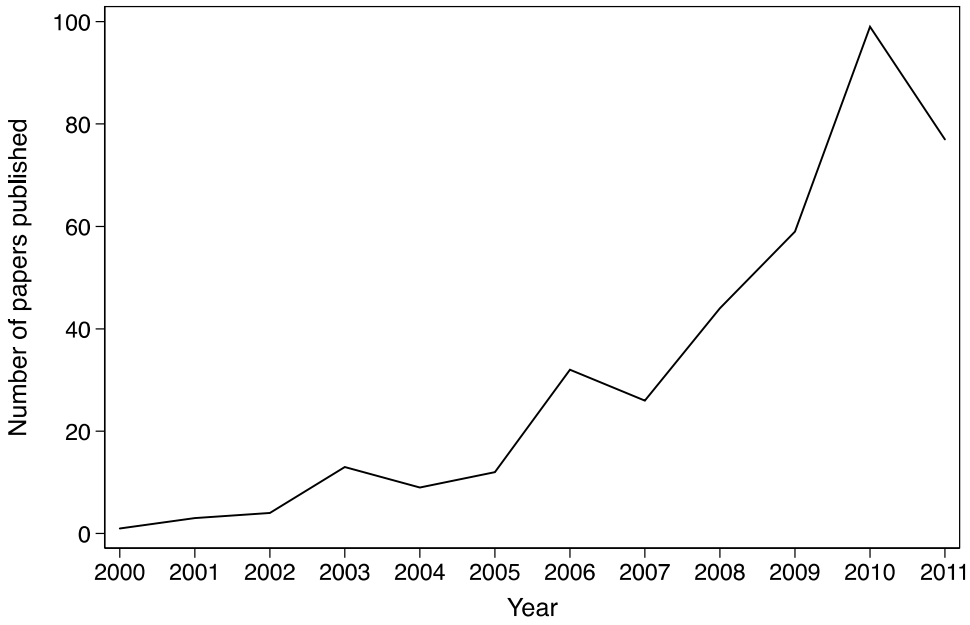
| Emerging Economies | | | | Advanced Economies | | | |
|---|---|---|---|---|---|---|---|
| | Subsidiaries | Patents | % Cross-country | | Subsidiaries | Patents | % Cross-country |
| India | 34 | 1158 | 51% | Japan | 65 | 5013 | 20% |
| China | 38 | 260 | 61% | France | 58 | 3518 | 24% |
| Philippines | 7 | 155 | 54% | UK | 101 | 3145 | 33% |
| Russia | 10 | 115 | 67% | Germany | 82 | 2995 | 35% |
| Hungary | 1 | 86 | 34% | Israel | 48 | 2090 | 34% |
| Thailand | 7 | 70 | 29% | Canada | 74 | 1887 | 43% |
| Czech Rep. | 8 | 53 | 55% | Switzerland | 30 | 826 | 50% |
| Brazil | 8 | 39 | 72% | Netherlands | 37 | 758 | 54% |
| Mexico | 11 | 37 | 62% | Singapore | 39 | 656 | 39% |
| Poland | 4 | 35 | 49% | Italy | 37 | 628 | 40% |
| Turkey | 5 | 31 | 97% | Taiwan | 49 | 490 | 42% |
| Ukraine | 4 | 26 | 62% | Malaysia | 22 | 476 | 39% |
| Argentina | 7 | 22 | 73% | S. Korea | 24 | 405 | 43% |
| Romania | 5 | 19 | 89% | Ireland | 25 | 367 | 37% |
| Egypt | 5 | 14 | 64% | Belgium | 24 | 249 | 71% |
| | | | | Denmark | 15 | 206 | 39% |
| | | | | Australia | 22 | 204 | 53% |
| | | | | Sweden | 21 | 149 | 50% |
| | | | | Spain | 14 | 130 | 61% |
| | | | | Hong Kong | 23 | 101 | 60% |
| | | | | Norway | 12 | 93 | 60% |
| | | | | Iceland | 6 | 54 | 54% |
| | | | | New | 10 | 45 | 56% |
| | | | | Austria | 10 | 40 | 65% |
| | | | | Finland | 13 | 38 | 47% |
| | | | | Greece | 5 | 15 | 93% |
| | | | | UAE | 2 | 10 | 100% |

*Source*: Alnuaimi, Singh and George (2011)

[6] Taiwan, Province of China

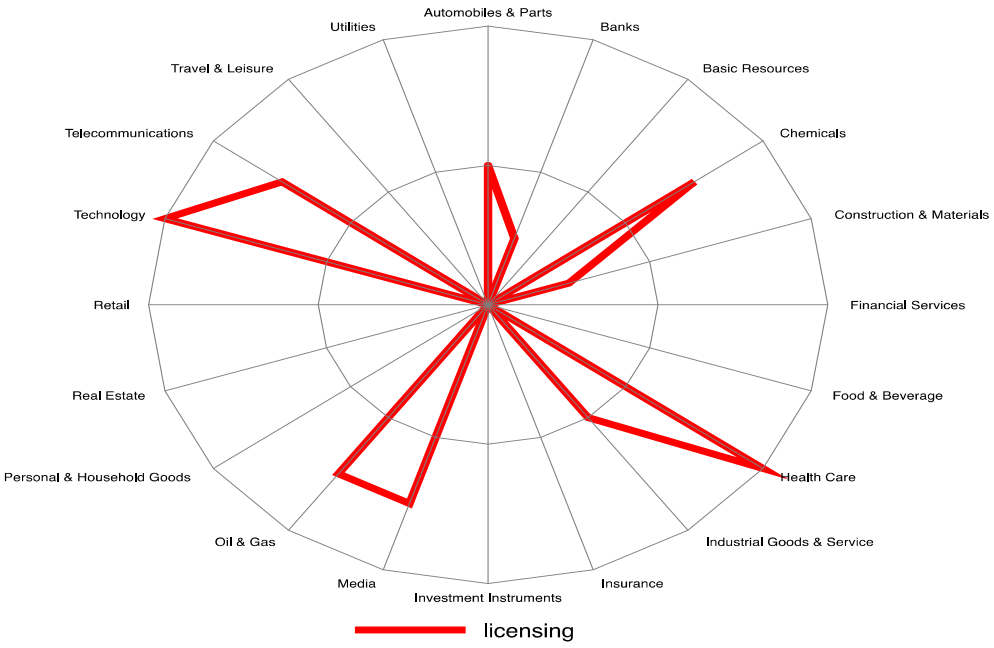
## LIST OF FIGURES:

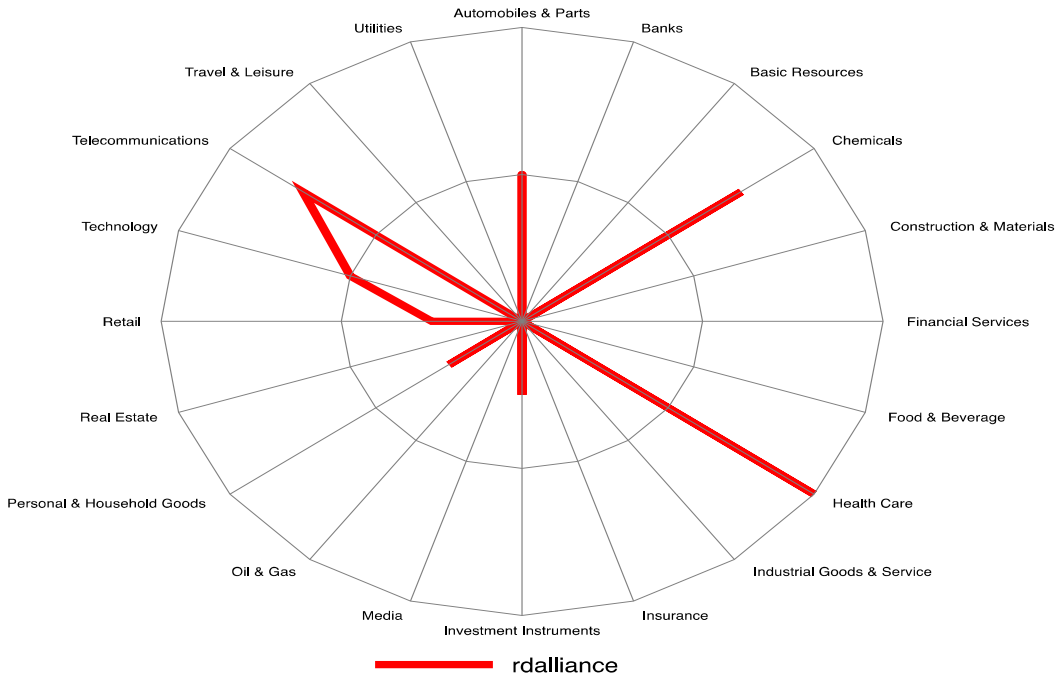
**Figure 1: Number of papers published and analyzed in the report**




*Note*: The number of papers decline in 2011 as an artifact of the construction of the database was completed in October 2011. The chart is therefore missing three months of papers published in the last quarter of 2011.
*Source*: Compiled for this report using the method described in Dahlander and Gann (2010).

**Figure 2a-c: Illustrating the application of different initiatives across industries**



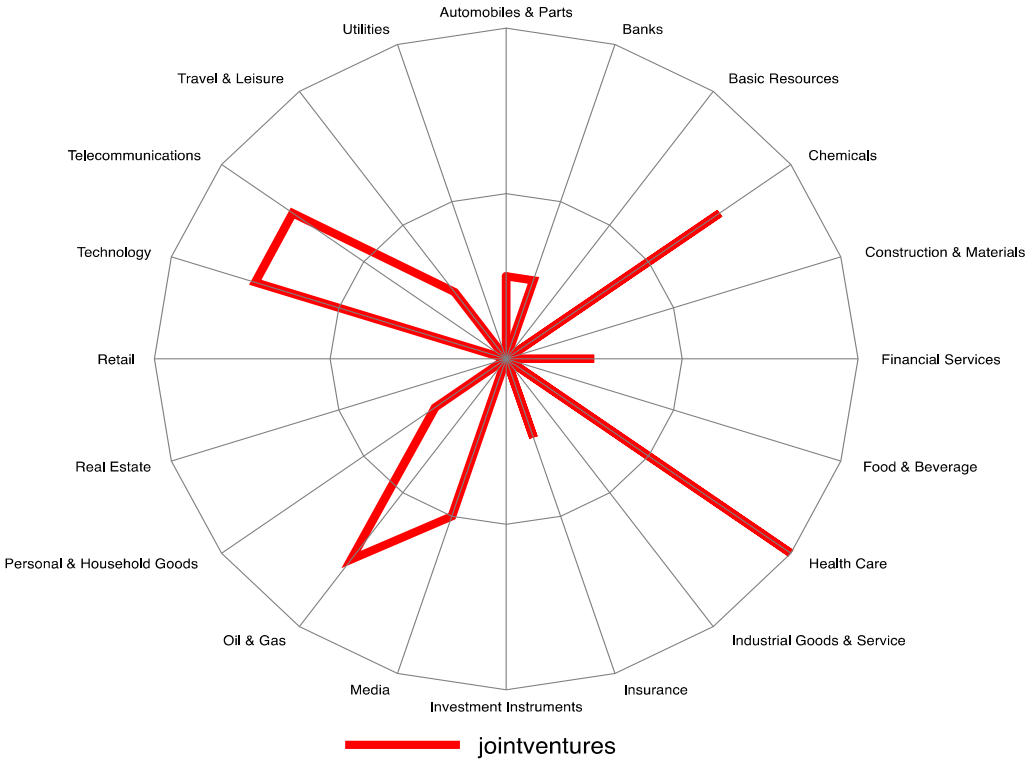
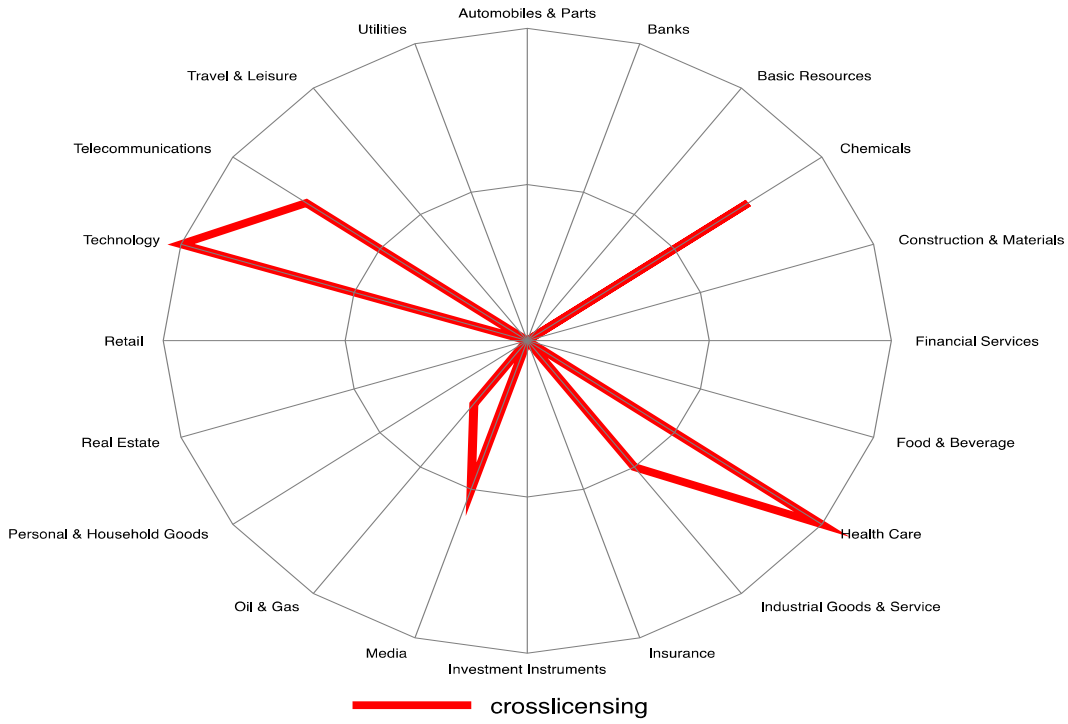
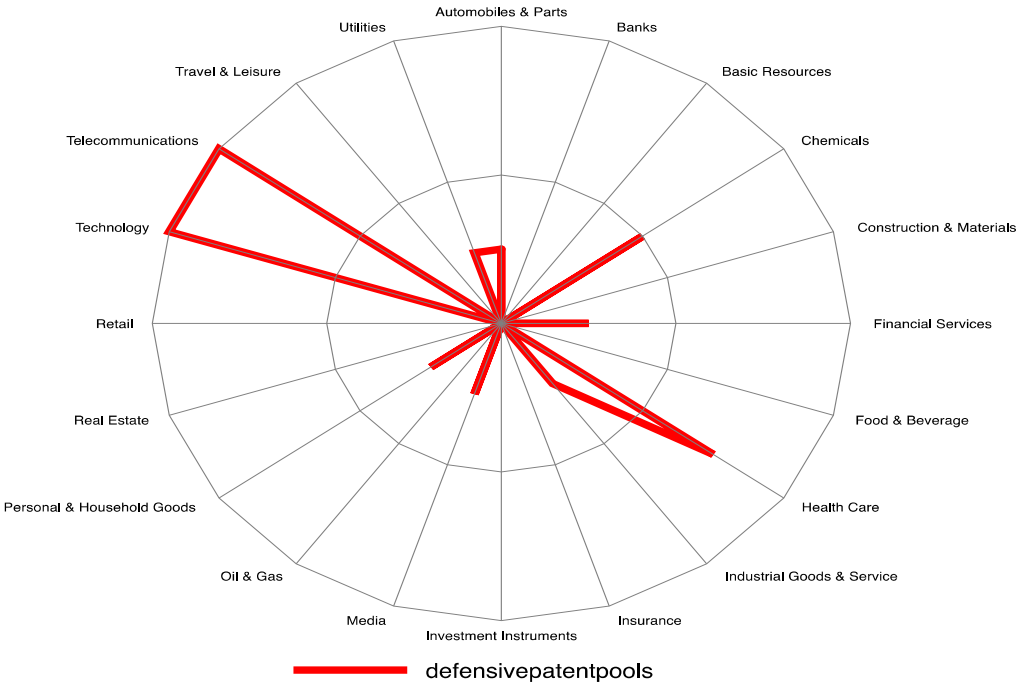

Automobiles & Parts
Banks
Basic Resources
Chemicals
Construction & Materials
Financial Services
Food & Beverage
Health Care
Industrial Goods & Service
Insurance
Investment Instruments
Media
Oil & Gas
Personal & Household Goods
Real Estate
Retail
Technology
Telecommunications
Travel & Leisure
Utilities
jointventures

**Figure 2d-f: Illustrating the application of different initiatives across industries**



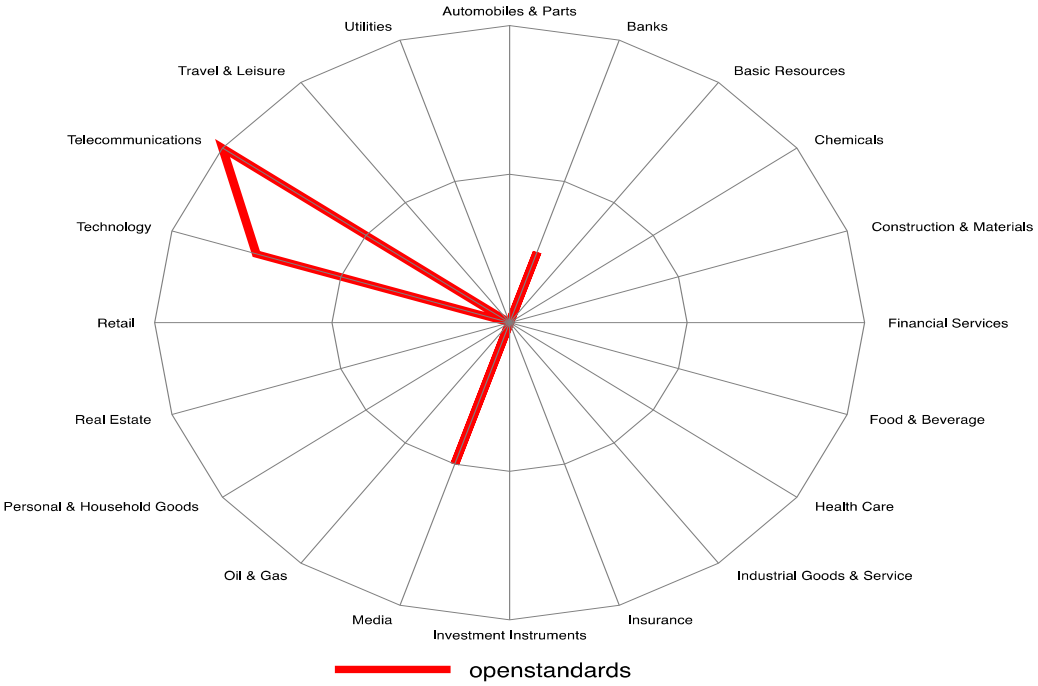
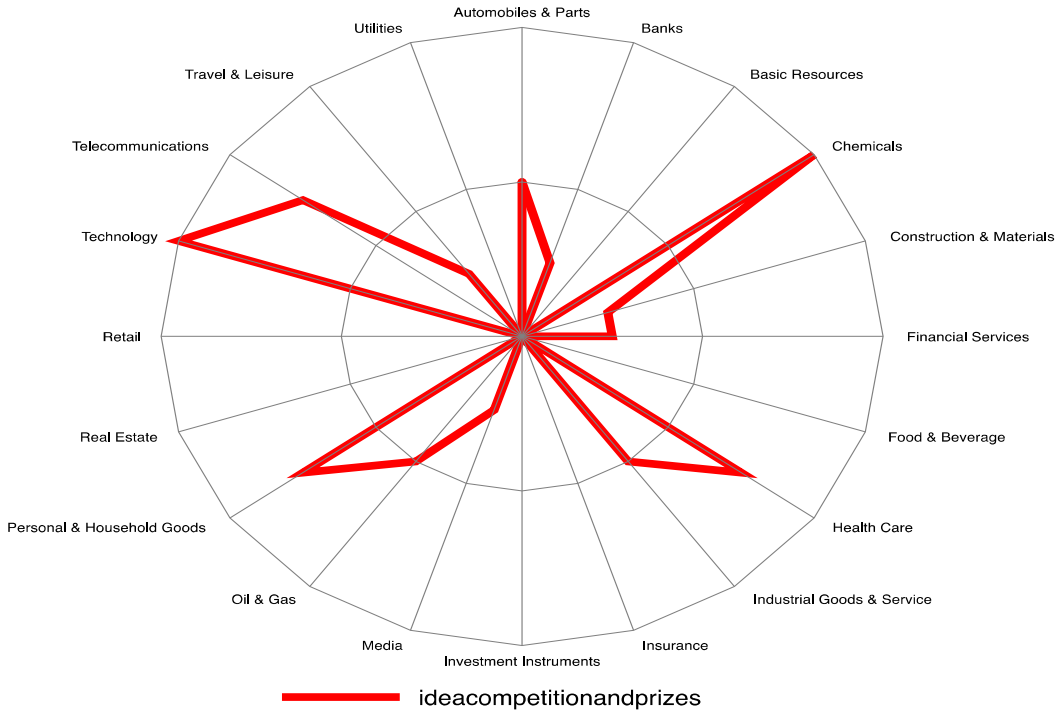

Automobiles & Parts
Banks
Basic Resources
Chemicals
Construction & Materials
Financial Services
Food & Beverage
Health Care
Industrial Goods & Service
Insurance
Investment Instruments
Media
Oil & Gas
Personal & Household Goods
Real Estate
Retail
Technology
Telecommunications
Travel & Leisure
Utilities
openstandards

**Figure 2g-h: Illustrating the application of different initiatives across industries**



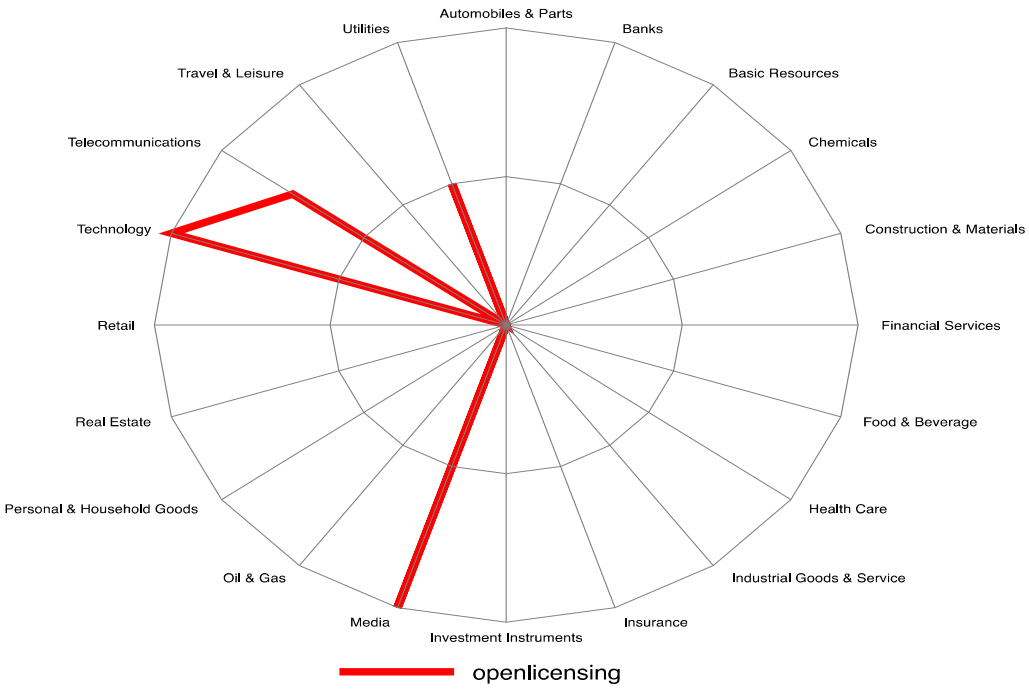
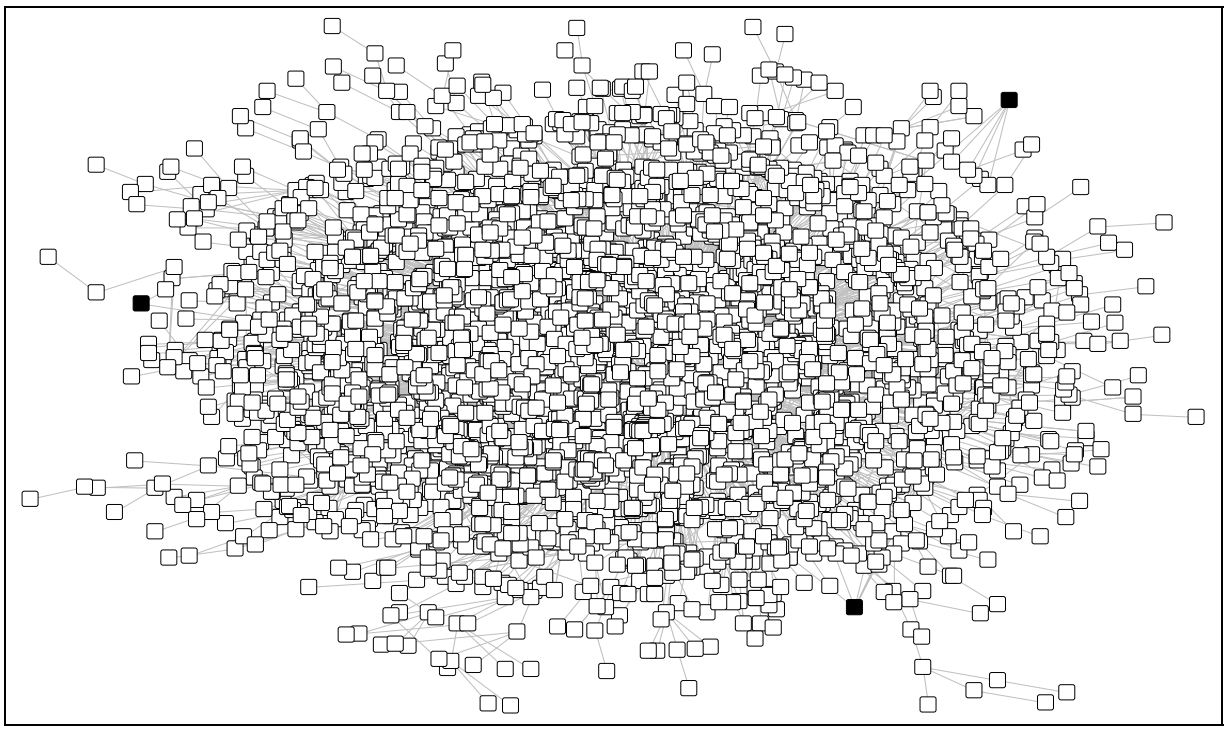
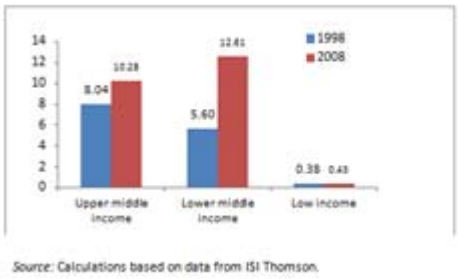



**Figure 3: Map of the cluster of innovator firms in the global patent network with the three largest Indian innovators (shaded solid black in the periphery)**



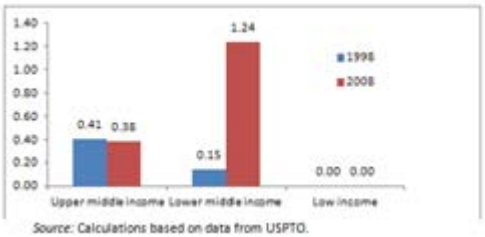
*Source*: Alnuaimi, Opsahl and George (2010)

**Figure 4a: ISI share of developing countries in scientific papers (word total)**




Source: Calculations based on data from ISI Thomson.

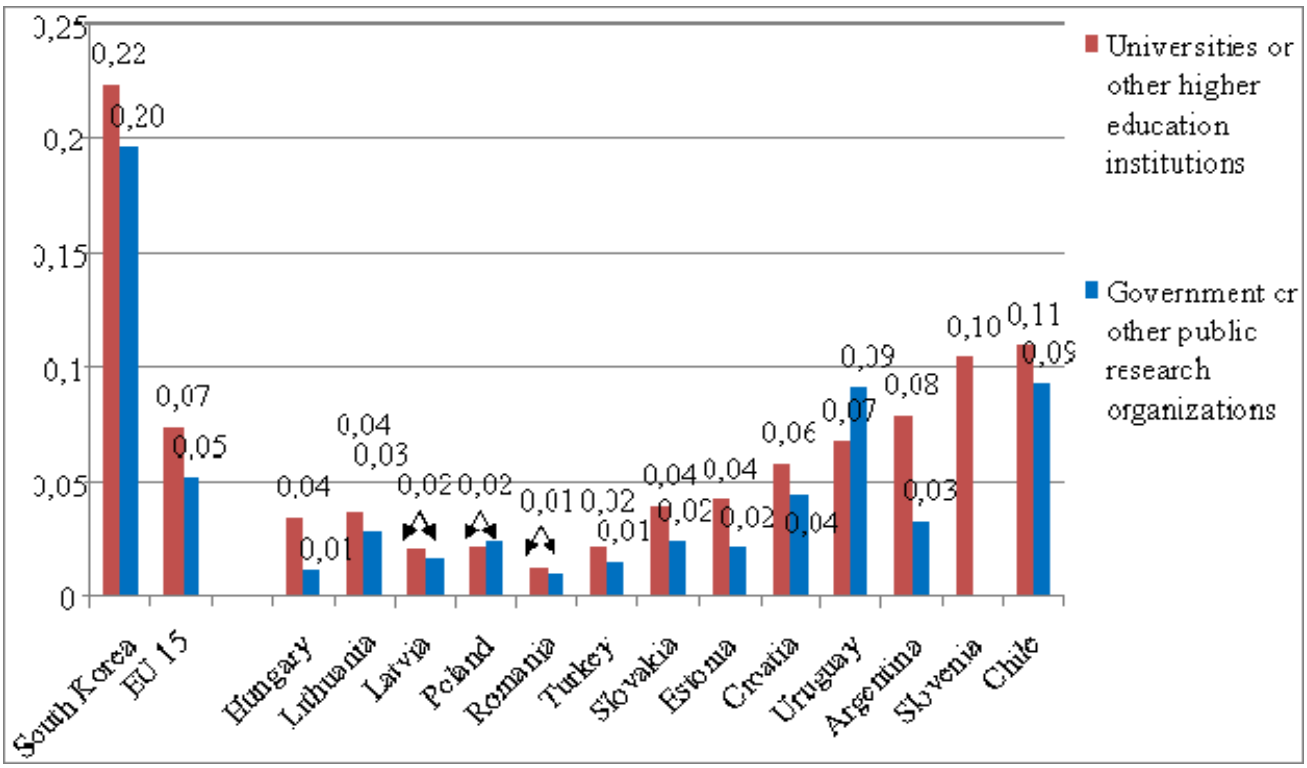
**Figure 4b: Share of developing countries in patents granted at USPTO (word total)**




Source: Calculations based on data from USPTO.

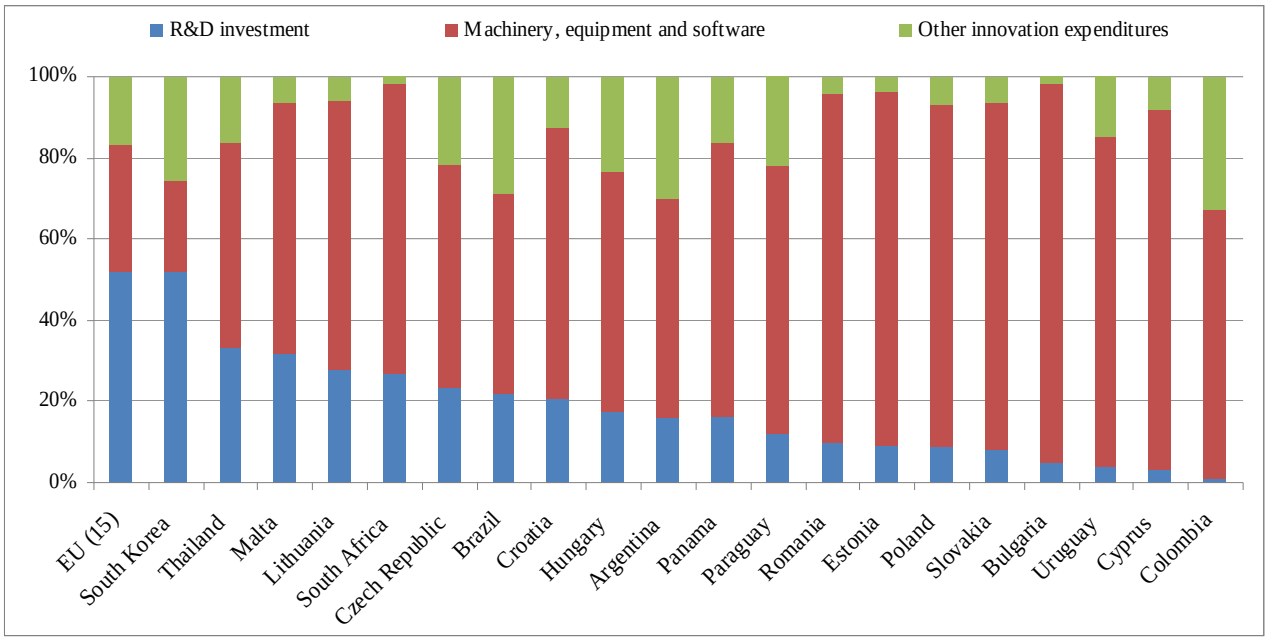
*Source*: Zuniga (2011: 93).

**Figure 5: Collaboration in innovation activities with universities and public agencies (Manufacturing Industry): Percent of firms in total engaged in collaboration**



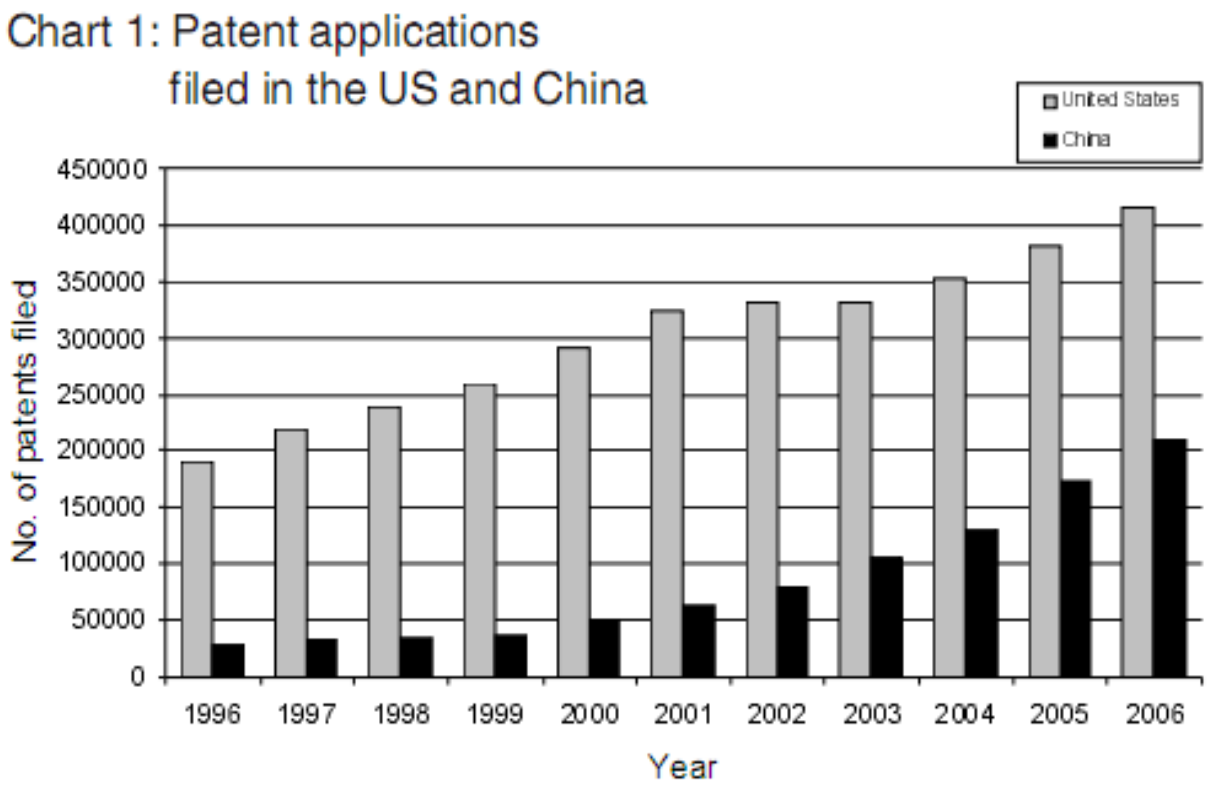

*Source:* Zuniga (2011) with data aggregated from multiple sources. The Indicator for EU-15 countries is from Eurostat and refers to innovation surveys 2006. The indicators for Hungary, Lithuania, Latvia, Poland, Romania, Turkey, Slovakia, Estonia, Croatia and Slovenia are from Eurostat Chronos and refer to innovation surveys 2006. The survey years for other countries are: Argentina: 2005; Uruguay: 2004-2006; Chile: 2005-06; and South Korea: 2005.

**Figure 6: Distribution of innovation expenditures by firms (Manufacturing Industry)**



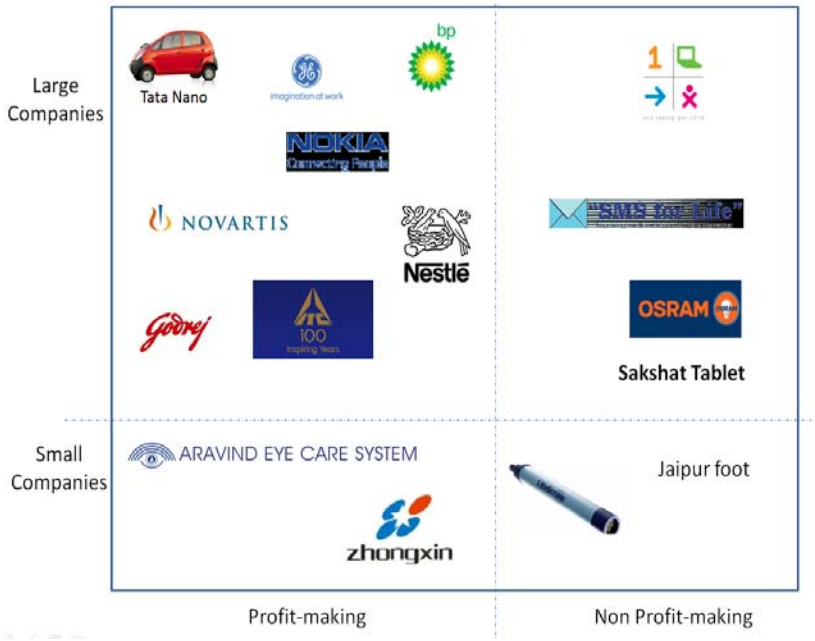

*Sources:* Zuniga (2011) with data aggregated from multiple sources. Innovation Surveys. Argentina: 1998-2001; Brazil: 2005; Colombia: 2003-2004; 2008; Uruguay: 2005-2006; Paraguay: 2004-2006; Thailand: 2003 and South Africa: 2002-04. Data for EU-15 countries are from Eurostat Chronos (Innovation surveys 2006); completed with data from OECD (2009) for Germany, South Korea and United Kingdom. For Estonia, Bulgaria, Cyprus, Lithuania, Hungary, Malta, Poland, Romania, Slovakia, Croatia and Turkey, data are from Eurostat Chronos, 2006.

**Figure 7: Patent applications filed in the US and China**




*Notes:* US (light shade) and China (dark shade)
*Source:* Fernando (2008)

**Figure 8: Categorization of different initiatives**




*Source:* This report.

[End of Annex and of document]