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Taxonomy-Analytical Study for the Project on Open Collaborative Projects and IP-Based Models (Recommendation 36)

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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.

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.

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EXECUTIVE SUMMARY

1. This report develops an analytical taxonomy to understand the role of intellectual property (IP) rights in open collaborative processes.

2. It is based on an extensive literature search and analysis of different forms of openness and appropriability regimes.

3. The analysis includes a range of different types of initiatives categorized in three themes: (1) those that facilitate the flow of knowledge between companies, (2) those that resolve ambiguity about ownership between companies, and (3) those that facilitate innovation between companies and individual users. For each initiative, the type of openness, the means of appropriability, the underlying IP model that supports it, as well as the potential benefits and challenges are reviewed.

4. These initiatives have varying extents across industries. Some initiatives have broader reach than others, such as internet-based prize competitions.

5. The report also 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 the 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.

6. 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.

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1. INTRODUCTION

7. 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 use of 'distributed' or 'open' innovation has received much recent attention from academics, managers and policy-makers. For example, Chesbrough (2003: XXIV) argues that "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". Individual organizations find it difficult to innovate on their own and need to collaborate with external constituents to acquire ideas and resources. Research has shown how this can enable organizations to leverage their internal R&D, and develop new inventions with fewer resources and at a greater pace.

8. 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 giving incentives to inventors, yet 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 and exemplify this with various initiatives.

9. 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)[*]. 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.

10. The trend towards open innovation processes can be explained by a combination of factors. First, organizational boundaries have become more porous: people move between companies to a greater extent than previously throughout their careers. Some argue that "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, collaborate and coordinate people between organizations and across geographical locations. Third, rapid economic development in BRIC and 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.

11. This report analyzes how openness and intellectual property rights 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. It can provide an opportunity for partnership, and the necessary protections to ensure ideas are not stolen. Research suggests that an effective IP system is vital to encourage the trade and interaction of external knowledge. A recent OECD report, for instance, suggests that "the effective management of IP is crucial, not only in identifying useful external knowledge but especially to capture the value of a firm's own IP rights" (OECD Report 2008 "Open innovation in global networks"). The trade surrounding the exchange of IP rights is increasing rapidly in OECD countries. IPRs can potentially also retard openness when organizations build patent portfolios as a means to gain bargaining power.

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

1.1 TERMS OF REFERENCE

12. 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

13. This analytical taxonomy extends 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’ and not only the specific term ‘open innovation’ or ‘openness’.

14. 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.

15. 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.

16. 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).

17. 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.

3. ANALYTICAL TAXONOMY

18. Many actors engage in innovation processes, including companies, universities, private research institutes to government agencies. Innovation processes do not just comprise the organizations in it, but the ways in which they work together. This has been the central idea in the literature on open and distributed innovation. What exactly "openness" entails is often unclear in this literature, and simply highlights that valuable ideas and resources can be commercialized both inside and outside the organization. It is often difficult to study openness as scholars use the term to study divergent things. For instance, some scholars discuss openness and refer to how companies source ideas from the outside, and others how non-core technologies and ideas can be licensed to others.

3.1. DIFFERENT FORMS OF OPENNESS

19. To clarify openness and to be able to discuss under what conditions it is beneficial, Dahlander and Gann (2010) categorized earlier work on open and distributed innovation 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, this shows that there are different things being analyzed under the open innovation umbrella. 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, and specify under what conditions it is beneficial. (Please see Table 1).

3.1.1. Acquiring

20. 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. The challenge is in creating the expertise to search for and evaluate potential inputs and in creating value from ideas acquired externally by combining them with internal resources.

3.1.2. Sourcing

21. 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 that 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). 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

22. This type of openness refers to how firms commercialize their inventions and technologies through selling or licensing-out resources to other companies. Underlying this research is the idea that some companies have a stock of unused knowledge and IP from which value could be derived. By selling or licensing these, companies can gain profits while allowing technologies to be commercialized by others. Some scholars argue that the potential of selling technologies have not been fully utilized: Gambardella et al. (2007) even suggest that the market for technology could be 70% larger should some obstacles be overcome. 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

23. This type of openness refers to how internal resources are revealed to the external environment. In particular, this approach deals with how firms reveal internal resources without immediate financial rewards, seeking indirect benefits. This research puts emphasis on how companies can promote adoption of their technologies that they can later benefit from or by preventing their competitors from claiming. The premise is that openness, caused by voluntarily divulging information to outsiders, can improve the probability of being successful (Alexy and Henkel, 20XX; von Hippel, 1988; von Hippel, 2005; Henkel, 2006; von Hippel and von Krogh, 2003). Henkel (2006), for instance, suggests that firms adopt strategies to selectively reveal some of their technologies to the public in order to elicit collaboration, but without any contractual guarantees of obtaining it.

3.2. DIFFERENT MEANS OF APPROPRIABILITY

24. 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 it becoming depleted. 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). When others could potentially free ride, this creates disincentives to invest in R&D.

25. 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, 1985; 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. To better understand this, Table 2 categorizes formal and informal means of appropriability, a classification often made in the literature. (Please see Table 2).

3.2.1. Formal means of appropriability

26. Formal appropriability mechanisms include patents, copyright, trademarks and industrial design rights. These IPRs can create an incentive to invent, helping the creator generate returns on their investments. IPRs are often considered as vital in knowledge-intensive industries, as industries where intangible assets are common grow faster than average. In an investigation for an emerging country such as Brazil, a report by Ryan proposes that strengthening IP systems promote economic development (Ryan 2010).

27. **Patents.** A patent is an exclusive right 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. Utility refers to inventions that solve specific problems, although what constitutes a problem is quite vague. Novelty is associated with whether the claimed invention is original. The non-obviousness criterion is associated with whether the invention was obvious to a skilled person at the time of the invention. To be granted a patent, the inventor needs to establish that the invention is a significant leap from "prior art", or earlier work. Trivial extensions of prior art are not granted patents.

28. Patents can be ineffective, depending on the type of knowledge involved. Patents do not always provide good protection on intellectual property, as they are costly and time-consuming to enforce. Empirical work in the US (Levin et al., 1987, Cohen et al., 1998) and Europe (Arundel et al., 1995) has shown that the effectiveness of patents as protection of knowledge differs across and even within industries.

29. **Trademarks.** Trademarks are brand names that involve any word, name or symbol, alone or in combination for use or intended use to distinguish sellers of *products* from one another. Service marks, on the other hand, are brand names that involve any word, name or symbol, alone or in combination for use or intended use to distinguish sellers of *services* from one another.

30. **Copyright.** Copyrights are exclusive rights granted by a national or international agency to the creator for their original work. This temporary monopoly is granted in exchange for public disclosure of their work. Copyright includes the right to copy, distribute and change the work.

3.2.2. Informal means of appropriability

31. 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 where formal means of appropriability are not effective, yet the appropriability regime remains strong as companies can rely on informal means of appropriability.

32. **Complementary assets.** 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 innovation is not a guarantee of successful commercialization: this process requires complementary assets that need to be used in conjunction with the knowledge about the innovation, such as distribution, service, manufacturing etc. By having access to those assets, the probability of successfully commercializing is increased.

33. **First-mover advantages.** 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 & Shapiro, 1985). New users are therefore influenced by what previous users have chosen, which causes a path-dependency (Arthur, 1989; David, 1985). 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 (Nelson, 1989). Related to this is the discussion about lead time and first-mover advantages. Lieberman & Montgomery (1988, 1998) 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.

34. **Secrecy.** Secrecy is almost self-explanatory, and 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 (Cohen, Nelson and Walsh, 2000). Secrecy often provides better protection for process innovation than for product innovations, as those are harder to reverse-engineer.

3.3. SUMMARY OF TAXONOMY

35. This analytical taxonomy focuses on two central aspects to innovators.

36. 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” and what is being exchanged and what the nature of this exchange is. Unarguably, researchers have used different focal points, and to specify those help us build a conceptual framework to analyze specific initiatives.

37. Second, it distinguishes between formal and informal means of appropriability that capture what organizations can do to protect their ideas and innovations given that there is a certain flow across organizational boundaries. From this reasoning, it is possible to classify different types of initiatives with the taxonomy as an analytical lens.

38. In summary, this taxonomy brings a deeper understanding of the complexity in terms of different means of protecting knowledge. Firms can rely on several means of protection, and their effectiveness vary largely depending on the industry, as well as to the specific situation of the firm (Levin et al 1987). A key insight of this is that the relative inefficiency of one mean 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

39. This section sets out various kinds of specific arrangements to cope with the balance between openness and appropriability. From the analytical taxonomy two dimensions emerged: (1) different types of openness clarify the flow across organizations as well as (2) means of appropriability to deepen our understanding of how organizations protect their ideas.

40. A range of different initiatives commonly cited in the academic literature is selected with regards to means in which organizations can make use of the external environment. The latter are categorized into three themes, by dividing these initiatives into those that facilitate (1) the flow of knowledge between companies, (2) resolving ambiguity about ownership between companies, and (3) facilitate cumulative innovation between companies and individual users. For each, the type of openness, the means of appropriability, the underlying IP model that supports it, as well as potential benefits and challenges are reviewed.

4.1. FACILITATE FLOW OF KNOWLEDGE BETWEEN COMPANIES

41. A number of different studies concur that the number of formal relationships between companies has increased rapidly the last two-three decades (Haagedoorn 2011; Schilling 2010). The arrangements that have been explored in this literature are used as the starting point. 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

42. 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.

43. Licensing enables an organization to bring inventions to the market through an external organization suitable for commercialization. Many organizations even develop technologies that are put on the shelf unused (Nerkar, 2007). There are also 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 70% larger.

44. Patents facilitate trading by providing opportunities for firms to overcome the disclosure paradox (Arrow and Nelson, 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 people 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.

4.1.2. Sub-contracting

45. 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

46. 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

47. A joint venture is a business agreement in which parties agrees 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

48. The last decades, the total number of patent applications has increased rapidly. Many scholars argue that patents are used for other purposes, than purely to protect returns from the invention. Companies often game the system to block their competitors from gaining turf, 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 to tackle the issue of when companies have built patent thickets that threaten the cumulative advance of technologies. 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

49. 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

50. 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.

51. 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). 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. 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. Website: http://www.mpegla.com/main/default.aspx

4.2.3. Defensive patent pool

52. 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. 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. Website: http://www.openinventionnetwork.com/

4.2.4. Open standard

53. 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

54. For companies to cooperate with users has a long tradition (von Hippel 1988; von Hippel 2005; Freeman, 1974). But the emergence of Internet has allowed organization to tap into a geographically dispersed workforce. Examples are diverse and range from the design of T-shirts, developing new software code, to find gold in Canada. It is thus necessary to develop a more systematic way to think about these initiatives. This form 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). External people self-select to solve a task, express their opinion or to articulate new pressing problems to be solved. In one form of crowdsourcing, the task is outsourced to a pool of potential solvers and the best solution gets 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 amount of connectivity among the participants that take part.

55. 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 that person that would be able to improve their recommendations with at least 10%. Another example is Innocentive that awards a pre-defined sum to that person that can solve a given task. In another form, potential options exist but the external group of people can be used to get 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. This has promise for organizations that can use this as a means to choose between different possible options. 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 design that could be printed and sold. 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. In open source, for example, many individuals come together to work on developing new source code although there is rarely more concrete goal than to develop the best graphical user interface, for example.

56. Table 4 summarizes the resulting framework that captures the diversity of initiatives. (Please see Table 4).

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

4.3.1. Prizes and idea competitions

58. 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, that was much more difficult than the latitude. 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 also faced problems of being recognized for many years.

59. Enabled by new technologies, prizes are again becoming more prevalent to find "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, whereas blue-sky prizes refer to where the type of invention is not specified in advance.

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. 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. 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. Website: http://www.nesta.org.uk/publications/guest_articles/assets/features/pg_corporate_open_innovation_challenge

4.3.2. Open licensing

60. In an era of digital information and technologies that allow for rapid exchange, some people have expressed concerns about the limits of traditional copyright that prevents people to copy, distribute and change the work. This is particularly evident in the creation of creative commons and open source licenses. These initiatives use the existing legal framework and tweak is to allow for others to build, modify, redistribute to varying degrees.

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”. 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. Wikipedia relies on different form of open licensing to ensure that content remains possible to access and modify. Wikipedia previously used an 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. 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. Websites: http://www.opensource.org/ and http://www.fsf.org/

4.3.3. Boundary organizations

61. Many of the Internet initiatives develop solutions beyond new forms of licensing practices. O'Mahony and Bechky looks 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. 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. According to BiOS, three conditions are necessary to access technologies: "To share with all BiOS licensees any improvements in the core technologies as defined, for which they seek any Intellectual Property protection. To agree to not assert over other BiOS licensees their own or third-party rights that might dominate the defined technologies. To agree to share with the public any and all information about the biosafety of the defined technologies." Website: http://www.bios.net

4.4. SUMMARY OF FINDINGS

62. 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:

63. 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, 2007; 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).

64. 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.

65. Third, many of the Internet enabled tools that have been designed with the intention to increase interactions between companies and users do not use traditional IP-based models.

Although patents and copyright do not apply for many of these initiatives, they still play a role. Open licensing, for instance, use existing copyright law to make sure some right 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

66. Empirical research on open innovation was initially primarily focused on case studies of large American companies in the high tech industries. From 2006 and onwards, case studies of other industries have emerged as well as large-scale empirical studies that span across industries.

67. 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 Jing (2011) informed this exercise. This approach has obvious shortcoming, and needs further evidence. Two noteworthy findings emerge from this exercise.

68. First, some initiatives have much broader reach than others. For instance, prize competitions have gained renewed interest with the emergence of Internet that allows for matching of 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.

69. Second, these results illustrates there is no "one recipe fits all". The extents to which initiatives are used across industries vary significantly. Some industries are much closer than others. The defense industry is very closed, only cooperate with other defense industry companies and rely on trade secrets.

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

70. The literature on openness is concentrated in the developed world. Table 5 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 5).

71. In many emerging economies, most notably the BRIC countries, intellectual property appear 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; Wang 2011; Alnuaimi, Puranam and George, 2011; Alnuaimi, Singh and George, 2011). 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; Frost, 2001; Thursby and Thursby, 2006). Some even argue that the quality of inventions 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.

72. 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 multinational 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, these innovating firms 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

73. With growing research capabilities in LDCs, innovation systems are at transitional stage; in many countries foundations exist but are weakly articulated (Arocena and Sutz, 1999; 2001; Gu, 1999). In 2008, LDCs 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 Advanced Economies 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).

74. Although, appropriate mechanisms of innovation, protection and appropriability exist in LDCs, 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 of the Gross Domestic Product (GDP), whereas in developed countries R&D investment represented 2.02 of the GDP. Further, these countries face great difficulties in retaining the talent given the poor job perspective 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. Among less developed countries Brazil, Russia, India and China (BRIC) countries are an exception where public and private sector R&D investment has substantially increased during the last decade. (Please see Figure 4).

75. Many LDCs lack a well-defined and unifying policy on innovation, technology transfer and protection of IPRs. In many less developed countries, 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. Dominant cultural patterns have often undervalued scientific knowledge for firm and industry development (Arocena and Sutz, 2001; Intarakummnerd et al., 2002; Govindaraju, 2010) and the interaction between science and industry is still not very frequent. 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).

76. Perhaps, the most active organizational form for R&D 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 6, Alnuaimi, Singh and George (2011) report the propensities of US MNC firms to collaborate with the subsidiaries to generate patents. 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 6).

77. 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 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).

78. 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, 2010a; OECD, 2007), enhancing collaboration with foreign universities, international research institutions and with the industry.

79. 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, 2010a). (Please see Figure 5).

80. 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 LDCs.

81. 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 LDCs 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 Figure 6).

82. 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 dependant 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 rarer but far from negligible "genuine" innovative capabilities.

83. 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

84. 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).

85. 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).

86. Though a wide range of appropriability methods are available for capturing value from innovation. Few formal methods used in emerging economies and LDCs include patents (foreign and domestic patent system), designs, trademarks, utility models and copyright and informal ones 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 which firms 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).

6.3. NEW BUSINESS MODELS AND OPEN SOURCED IDEAS

87. As discussed, weak institutional infrastructure continues to hamper broad innovation ecosystem development efforts. However, this does not imply that innovation lags behind. Instead, innovations have emerged that adapt to local resource constraints and local market needs. 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.

88. Local education needs and the cost price at which education can be made accessible in a country like India. Based on 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[†] 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.

89. 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"[‡] 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.

90. '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[§], the prosthetic leg developed by BMVSS was designed to be inexpensive, quick to fit and manufacture, and to be water-resistant was developed at a cost of approx $30. Similarly, Lifestraw is a simple straw that filters water and is widely circulated in Africa where water-borne illnesses are rampant.

91. In the adjacent figure 7, examples of innovations are clustered by size and profit-making goals. (Please see Figure 7). 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. Chotukool, a $55 refrigerator does not have a compressor, and

[†] http://en.wikipedia.org/wiki/Sakshat
[‡] http://www.rbm.who.int/psm/smsWhatIsIt.html
[§] http://en.wikipedia.org/wiki/Jaipur_foot

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.

92. Innovating firms differ in the mechanisms they use to protect the knowledge they create. These differences relate to firm-specific factors (such as size, capability or innovation strategies), knowledge-specific factors (tacit vs. codified), technology-specific factors (e.g. product vs. process innovations) and industry-specific factors (e.g. life-cycle stages and appropriability regimes). Emerging economy inventions, apart from formal appropriability mechanisms, adopt a rich array of informal mechanisms including exploitation of lead time, the use of complementary capabilities (manufacturing, marketing and after-sales), and attempt to move rapidly down the learning curve to reduce costs.

93. 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 a 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.

7. CONCLUSIONS

94. Open and distributed innovation has gained popularity among academics as well as companies (Jazairy 2010). For instance, a recent OECD report claims that many companies are using open innovation, but it is less clear if practices have actually changed or whether this is a matter of "window-dressing". This report sought to move beyond this hype and look at what openness entails, what means are available to protect innovations, and how this applies in different initiatives.

95. First, the 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 attempts to find relevant variables to compare. What emerges is the importance of considering both advantages and disadvantages of each initiative, to understand the opportunities and challenges these pose for organizations.

96. Second, different types of openness are often combined. This becomes evident when analyzing different initiatives. Studies of open innovation thus need to capture different forms of openness. For instance, companies can reveal technologies to external people, 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.

97. Third, the applicability of these initiatives vary 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, 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.

98. Fourth, the role of intellectual property is changing and it can both impede and aid the innovation process. 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".

99. Fifth, Internet has changed, or created new opportunities, for business to connect users. For instance, although platforms and prize competitions are old ideas, they have gained renewed interest with the emergence of Internet. Internet has scaled the extent of the market so that scientists, engineers and other skilled people from around the globe could potentially contribute. 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.

100. 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 is waived to the benefit of future creators. Even prize competitions have the same pattern. For these intermediaries to work, they need to create monitoring mechanisms that build trust into the system.

LIST OF REFERENCES:

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. Working paper, Imperial College London.

Anlló, G., & D. Suárez. 2009. Innovación: Algomásque I+D. EvidenciasIbeoramericanas a partir de lasencuestas de innovación: Construyendolasestrategiasempresariascompetitivas. CEPAL-REDES, Buenos Aires, Unpublished.

Arocena, R. and 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.

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.

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

Chesbrough, H. 2003b. The logic of open innovation: Managing intellectual property. California Management Review, 45(3), 33.

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

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

Chesbrough, H. and Appleyard, M.M. 2007. Open innovation and strategy. California Management Review, 50(1), 57-76.

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

Christensen, J.F., Olesen, M.H. and 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. and Levinthal, D.A. 1990. Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly, 35(1), 128-152.

Dahlander, L. and Gann. D. M. 2010. How open is innovation? Research Policy 39: 699-709.

Dodgson, M., Gann, D. and Salter, A. 2005. Think, Play, Do: Markets, Technology and Organization. Oxford University Press, London.

Fey, C. and Birkinshaw, J. 2005. External sources of knowledge, governance mode and R&D performance.Journal of Management, 31(4), 597-621.

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

Frost, T., Zhou, C. 2005.R&D co-practice and “reverse” knowledge integration inmultinational 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. and A. Luzzi. 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., $35.00, ISBN: 1-57851-837-7). Research Policy, 34(1), 122-123.

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

Gassmann, O. and Enkel, E. 2006. Towards a theory of open innovation: Three core process archetypes. R&D Management Conference.

George G, Prabhu GN. 2003. Developmental financial institutions as technology policy instruments: implications for innovation and entrepreneurship in emerging economies, Research Policy, 32: 89-108.

Govindaraju, C. V. G. R. 2010. R&D commercialization challenges for developing countries -The case of Malaysia. V.G.R. Tech Monitor, Dec. 2010, pp. 25-30.

Gu, S. 1999. China’s Industrial Technology, Market Reform and Organizational Change, Routledge in association with the UNU Press, London and New York, 1999.

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 Developmand Studies, New Delhi, India.

Helfat, C.E.C. 2006. Book review of open innovation: The new imperative for creating and profiting from technology. Academy of Management Perspectives, 20(2), 86.

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.

Intarakumnerd, P., Chairatana, P., and Tangchitpiboon, T. 2002. National innovation systems in less successful developing countries: the case of Thailand. Research Policy 31: 1445-1457.

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

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. and Panetta, J.A. 2006. The value of openness in scientific problem solving. HBS Working Paper Number: 07-050. Harvard Business School.

Laursen, K. and 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. and Salter, A.J. 2006a. 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.

Liebeskind, J.P. 1996. Knowledge, strategy, and the theory of the firm.Strategic Management Journal, 17, 93-107.

López, L.E. and Roberts, E.B. 2002. First-mover advantages in regimes of weak appropriability: the case of financial services innovations. Journal of Business Research, 55, 997-1005.

Lopez, A. 2009. Innovation And Appropriability, Empirical Evidence And Research Agenda, WIPO International 2009

Menon, T. and 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.

Navarro, J.C., Llisterri, J. and 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.

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.

Rivette, K. and Kline, D. 2000. Rembrandts in the Attic: Unlocking the Hidden Value of Patents. Harvard Business School Press, 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.

Scotchmer, S. 1991. Standing on the shoulders of giants: Cumulative research and the patent law. Journal of Economic Perspectives, 5, 29- 41.

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

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. and 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. Ewing Marion Kauffman Foundation: Washington, DC.

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

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

van de Vrande, V., de Jong, J.P.J, Vanhaverbeke, W. and de Rochemont, M. 2009. Open innovation in SME:s: Trends, motives and management challenges.

vonHippel, E. 1988. The Sources of Innovation. Oxford University Press, New York.

vonHippel, E. 2005. Democratizing Innovation. The MIT Press, Cambridge (MA).

vonHippel, E. and von Krogh, G. 2003. Open source software and the private-collective innovation model: Issues for organization science. Organization Science, 14(2), 209-223.

vonZedtwitz, M. and 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.

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

Wu, W. 2010. Managing and incentivizing research commercialization in Chinese Universities.Journal of Technology Transfer, 35: 203–224.

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 DC.

LIST OF TABLES:

Table 1: Different types of openness

	Inbound innovation	Outbound innovation
Pecuniary	**Acquiring** 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** Out-licensing or selling products in the marketplace (e.g. Lichtenthaler and Ernst 2009, Chesbrough and Rosenbloom, 2002)
Non-pecuniary	**Sourcing** 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** 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: Different means of appropriability

Category	Explanation
Formal appropriability or Intellectual Property Rights	
Patents	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 that the invention is publicly disclosed. Although the exact criteria for patents differ across agencies, the criteria are usually utility, novelty and non-obviousness.
Trademarks	Trademarks are brand names that involve any word, name or symbol, alone or in combination for use or intended use to distinguish sellers of *products* from one another. Service marks, on the other hand, are brand names that involve any word, name or symbol, alone or in combination for use or intended use to distinguish sellers of *services* from one another.
Copyrights	Copyrights are exclusive rights granted by a national or international agency to the creator for their original work. This temporary monopoly is granted in exchange for public disclosure of their work. Copyright includes the right to copy, distribute and change the work.
Informal appropriability	
Complementary assets	Complementary assets are those assets that are not directly related to the invention that are necessary for successful commercialization such as distribution and marketing.
First-mover advantages	First-mover advantages refers to how early entry to the market can create advantages by acquiring superior resources and capabilities, and attracting lock-in effect from a large user base.
Secrecy	Secrecy refers to keeping the underlying knowledge behind an invention secret within the organization, without disclosing it to external constituents.

Table 3a: Analysis of initiatives

Type of initiative	**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. Means of acquiring or selling knowledge to outside organizations.	Outsource the creation of knowledge to external party. Means of acquire or selling a task to an outside organization.	Collectively develop knowledge with external party. 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. 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". Patents and copyright important to facilitate trade of knowledge and information.	The contract specifies the task and that the contractor gains the IPRs 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). 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 - Promote a patent race to have a portfolio of patents to work as bargaining power (patent thicket)	+Overcome internal resource constraints - Monitoring problems and risk of losing access to key technologies	+ Overcome internal resource constraints + Flexibility - Increased coordination costs - Ownership ambiguity	+ Share gains and losses with other organizations - Greater reliance on external actors

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. 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 Means of establishing a playing field for using one another's patents.	Defensively publish to enable the cumulative advance in a technological area. 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 as parties are generally already using the technologies or creative works. Patents or copyrights that were previously blocking parties can then be used without risking legal consequences.	When multiple parties are blocking one another, patent pools can increase the freedom for organizations, yet maintain competition in the product market. 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. 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 - Raise potential anti-trust concerns	+ The pool allows the licensee to know what they license without worrying about complementary rights + Clear blocking of technologies +Works well if technologies are complements - 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 - Skeptics claim companies are not contributing with key patents - 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 + Allow competition between companies within the open standard - 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 Other examples might help

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. 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. 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. 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. 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. 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 - Attention problems may surface – too much to choose from	+ Allow for recombination and extension of work. - Many different licenses to understand - Organizations must understand how and when licenses can be combined	+ Promote collaboration between actors with different underlying interests - Takes time to build trust - Difficulty in founding shared interests
Empirical examples	InnocentiveMathworks Netflix competition Threadless	Wikipedia Creative Commons Open source licenses (there exist hundreds of variants)	Wikipedia Open source communities

Table 4: Categorization of different types of Internet-enabled initiatives

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

Table 5: 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.

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

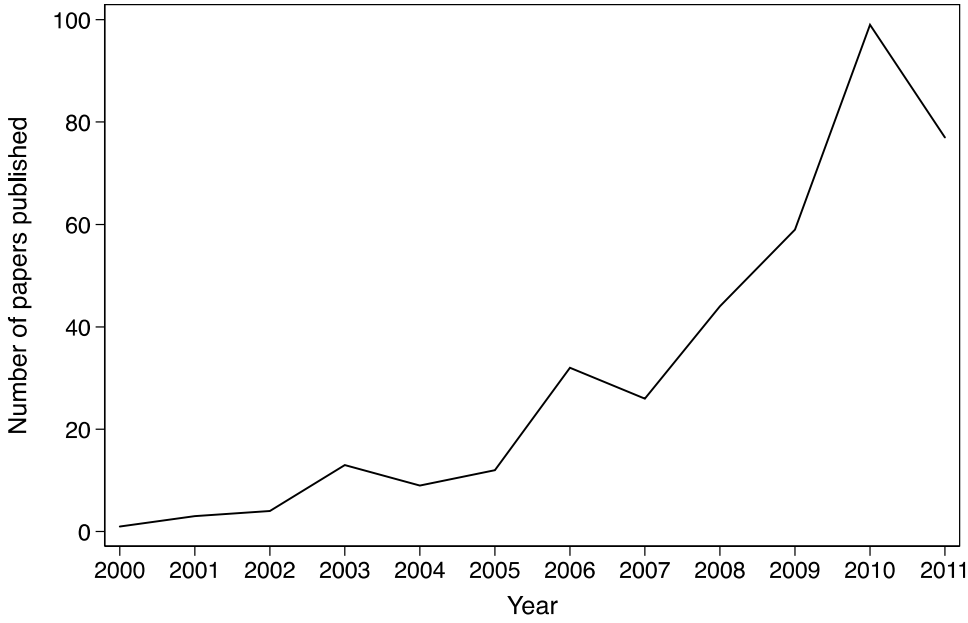
Patenting trends by foreign subsidiaries of US semiconductor MNCs

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%

[**] Taiwan Province of China

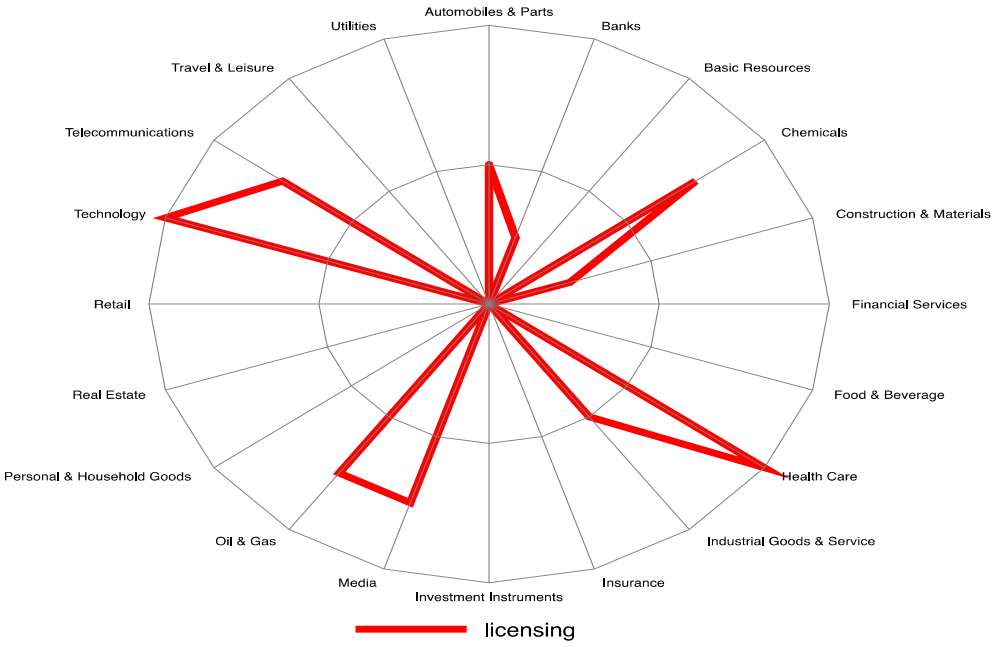
LIST OF FIGURES:

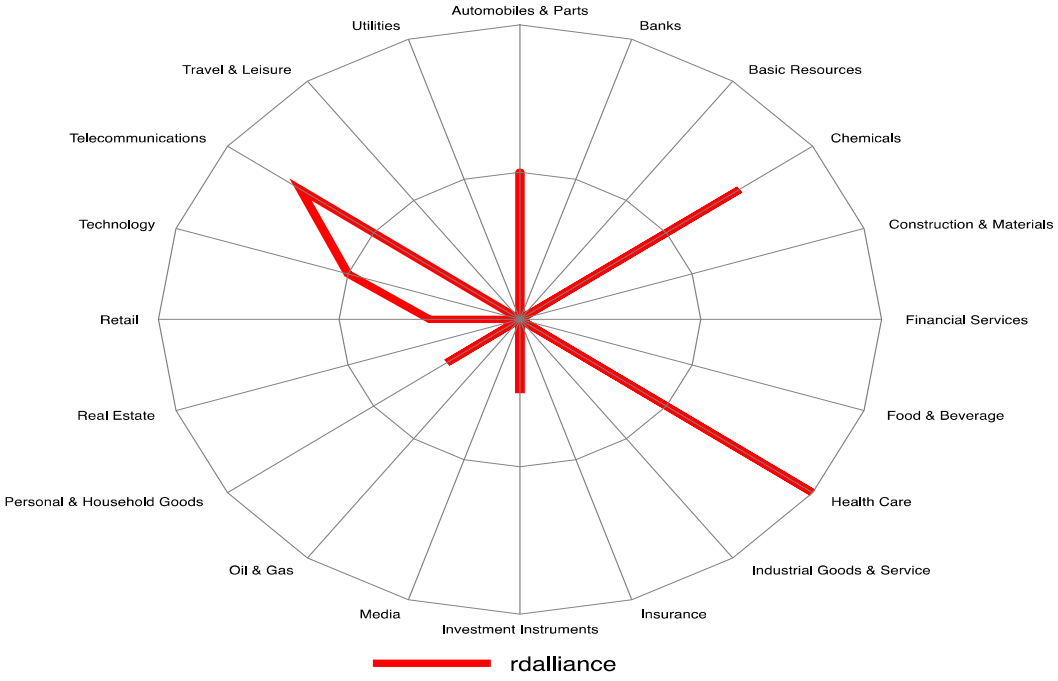
Figure 1: Number of papers published and analyzed in the report



Note: The number of papers decline in 2011 as an artifact of the construction of the database was completed in October 2011. We are thus missing three months of potential papers in 2011.

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





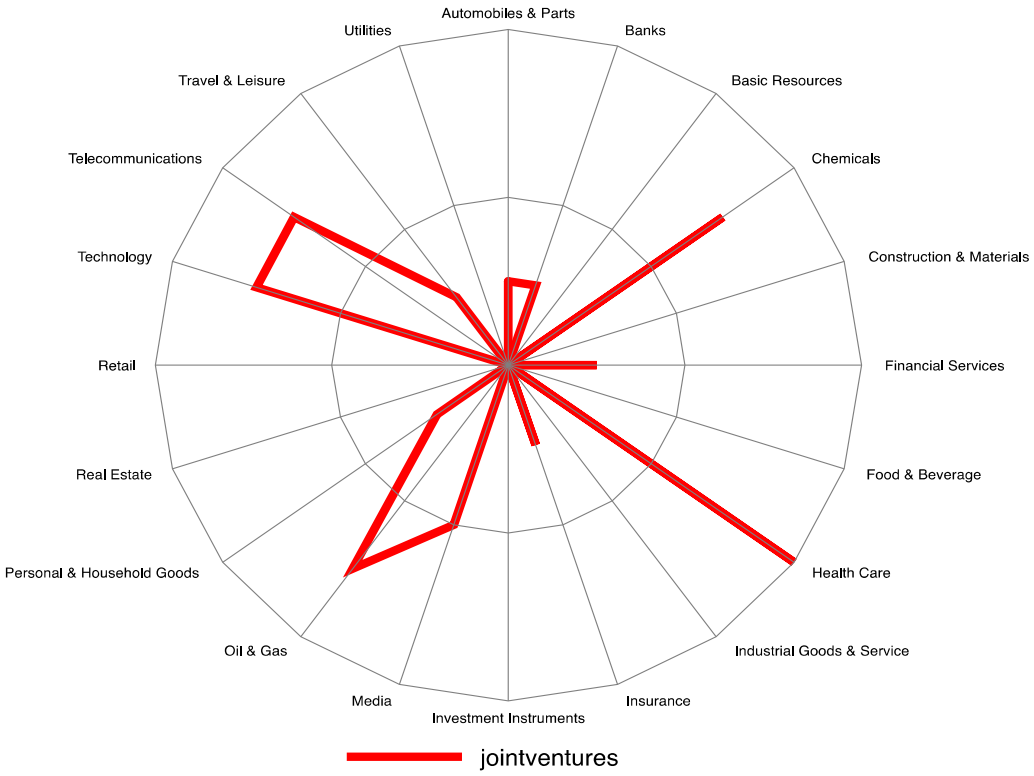
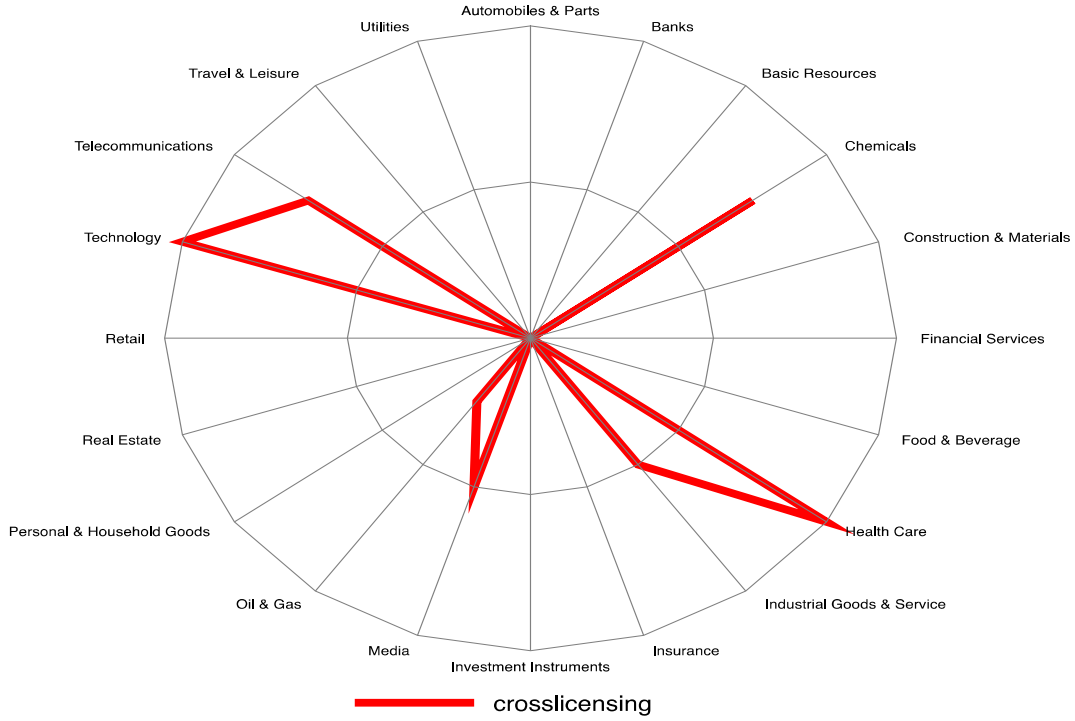
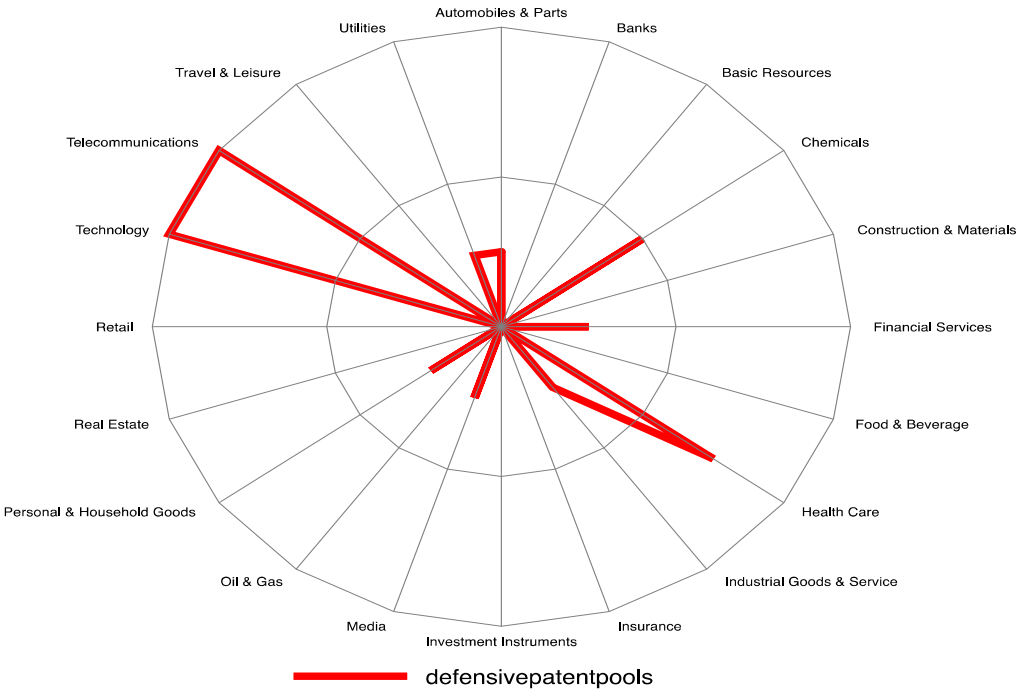

Automobiles & Parts
Banks
Basic Resources
Chemicals
Construction & Materials
Financial Services
Food & Beverage
Health Care
Industrial Goods & Service
Insurance
Investment Instruments
Media
Oil & Gas
Personal & Household Goods
Real Estate
Retail
Technology
Telecommunications
Travel & Leisure
Utilities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

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





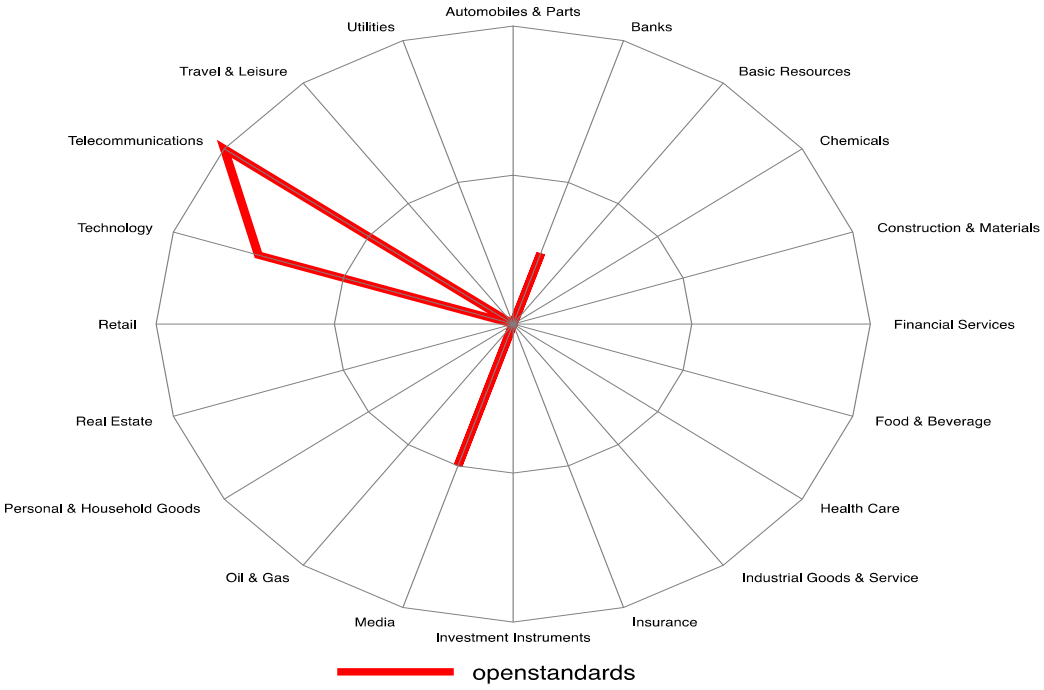
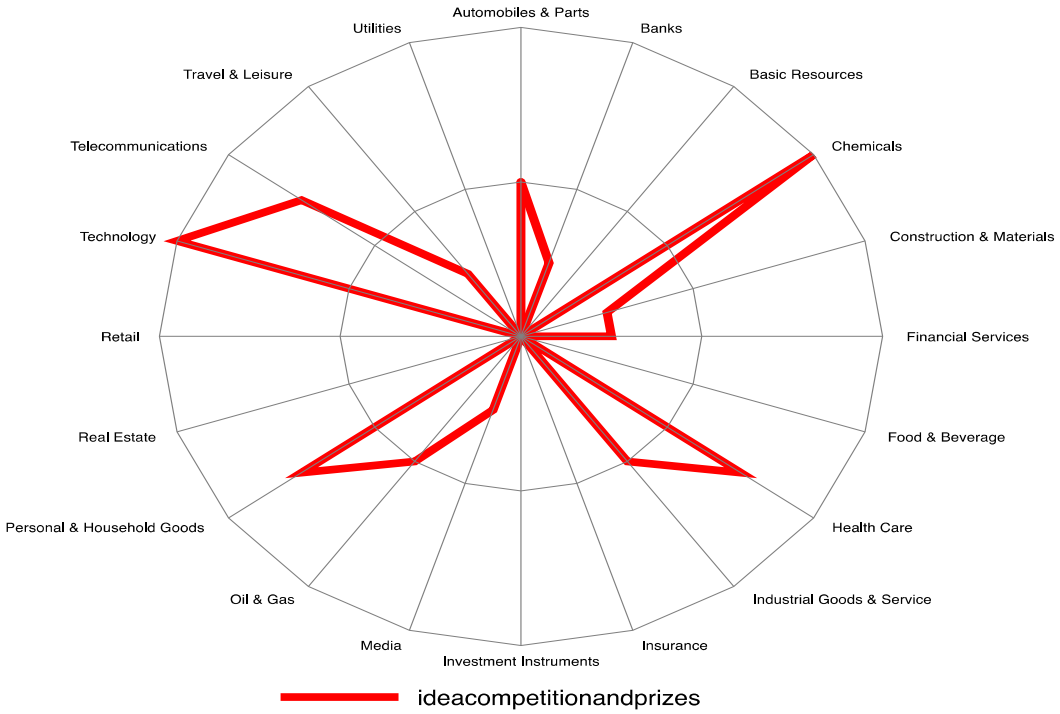

Automobiles & Parts
Banks
Basic Resources
Chemicals
Construction & Materials
Financial Services
Food & Beverage
Health Care
Industrial Goods & Service
Insurance
Investment Instruments
Media
Oil & Gas
Personal & Household Goods
Real Estate
Retail
Technology
Telecommunications
Travel & Leisure
Utilities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

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



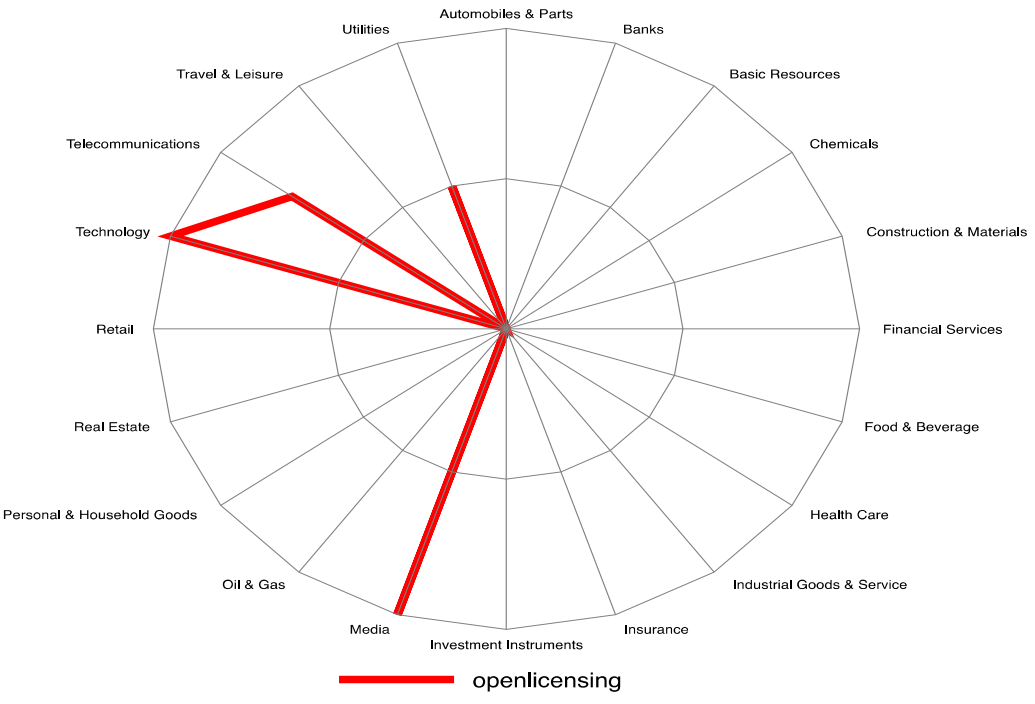


Figure 3:

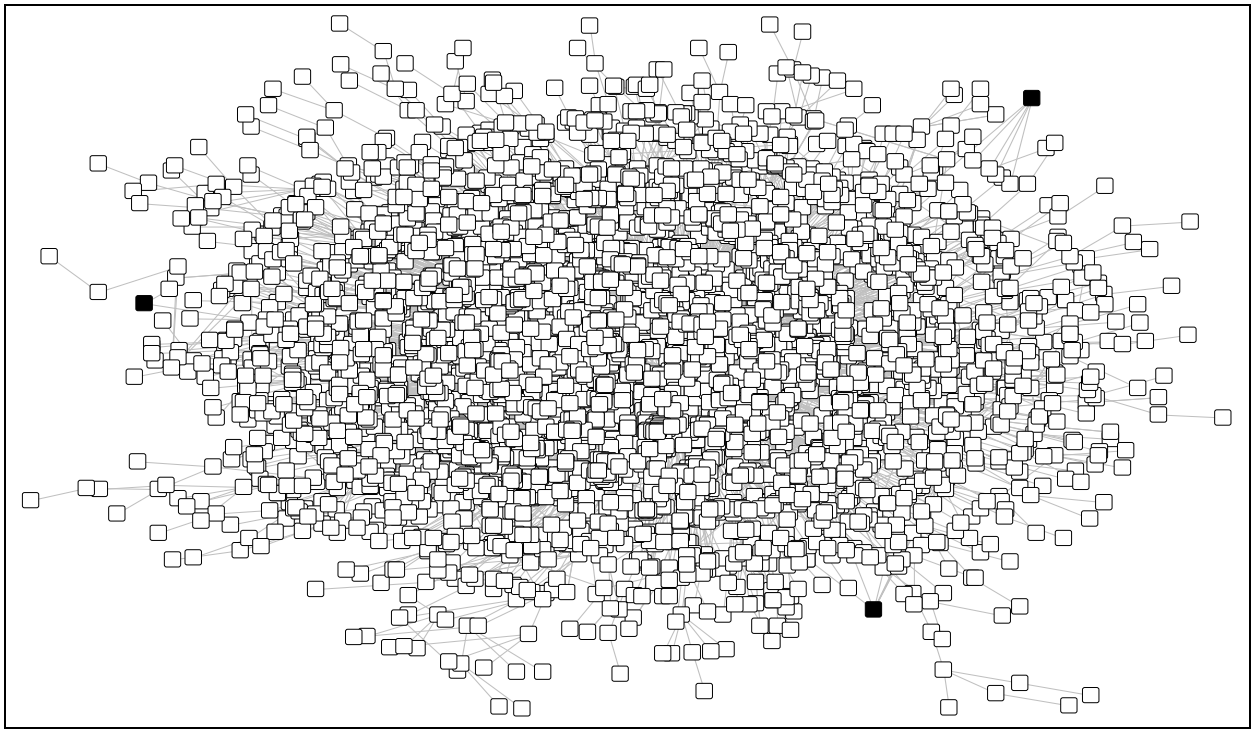
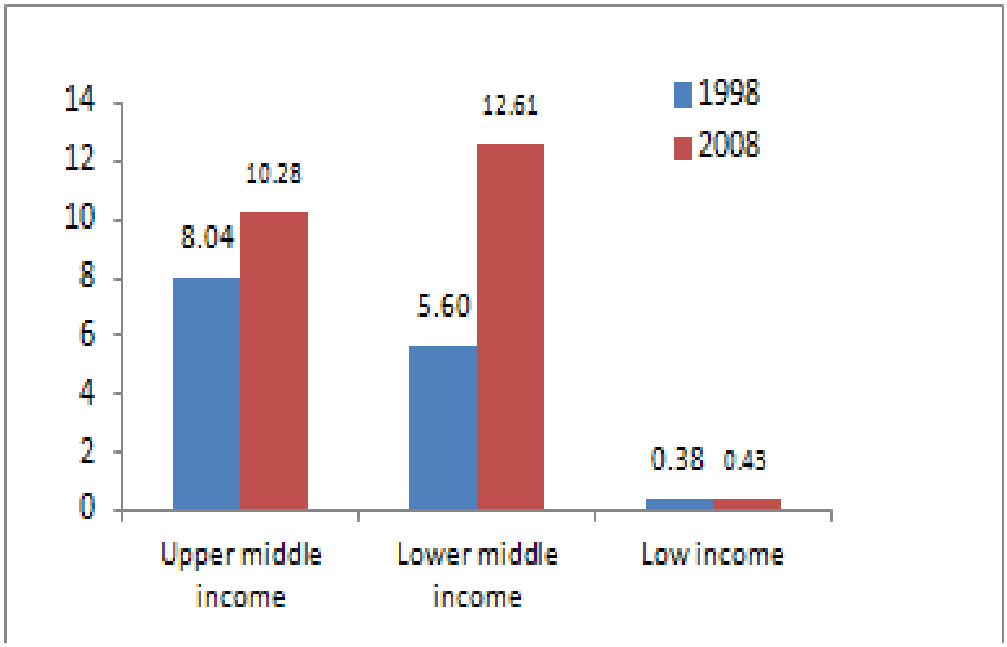


Figure 4:

Figure 1: ISI Share of developing countries in scientific papers (word total)



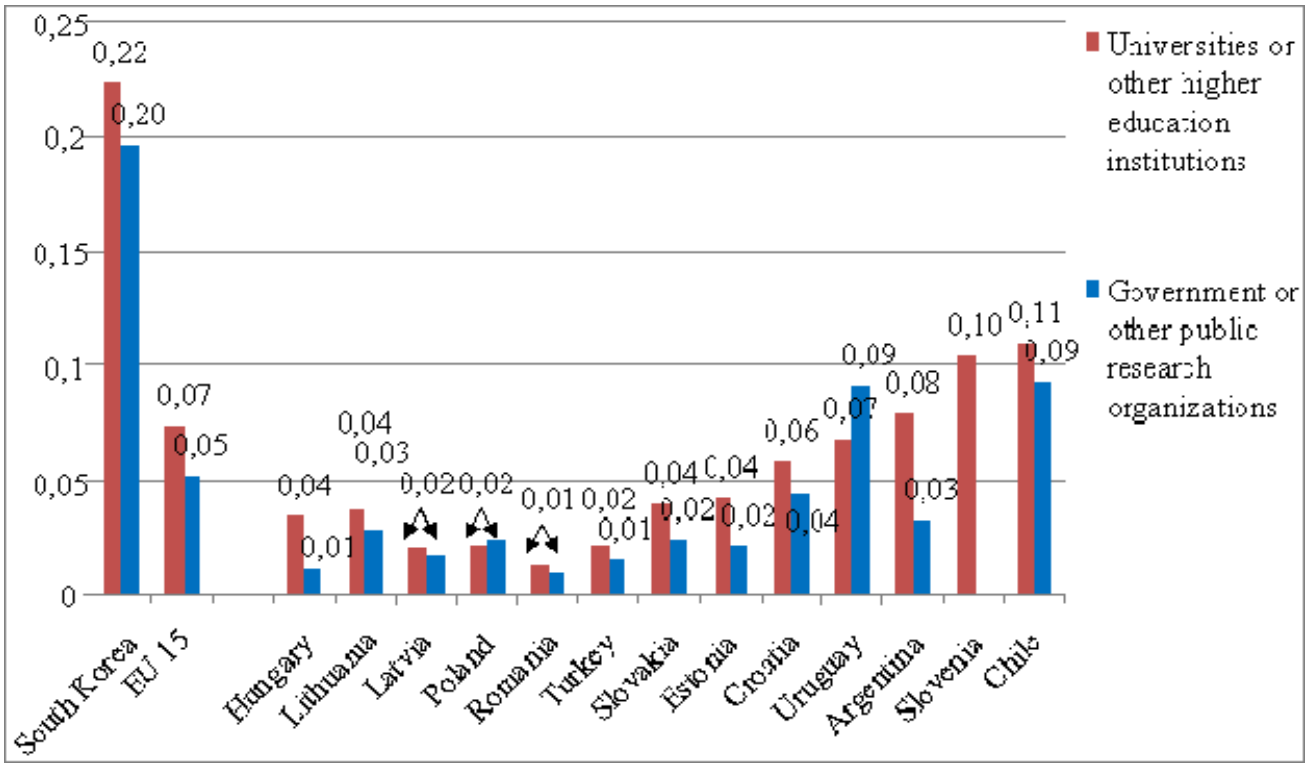
Source: Calculations based on data from ISI Thomson.

Figure 2: Share of developing countries in patents granted at USPTO (word total)

Source: Calculations based on data from USPTO.

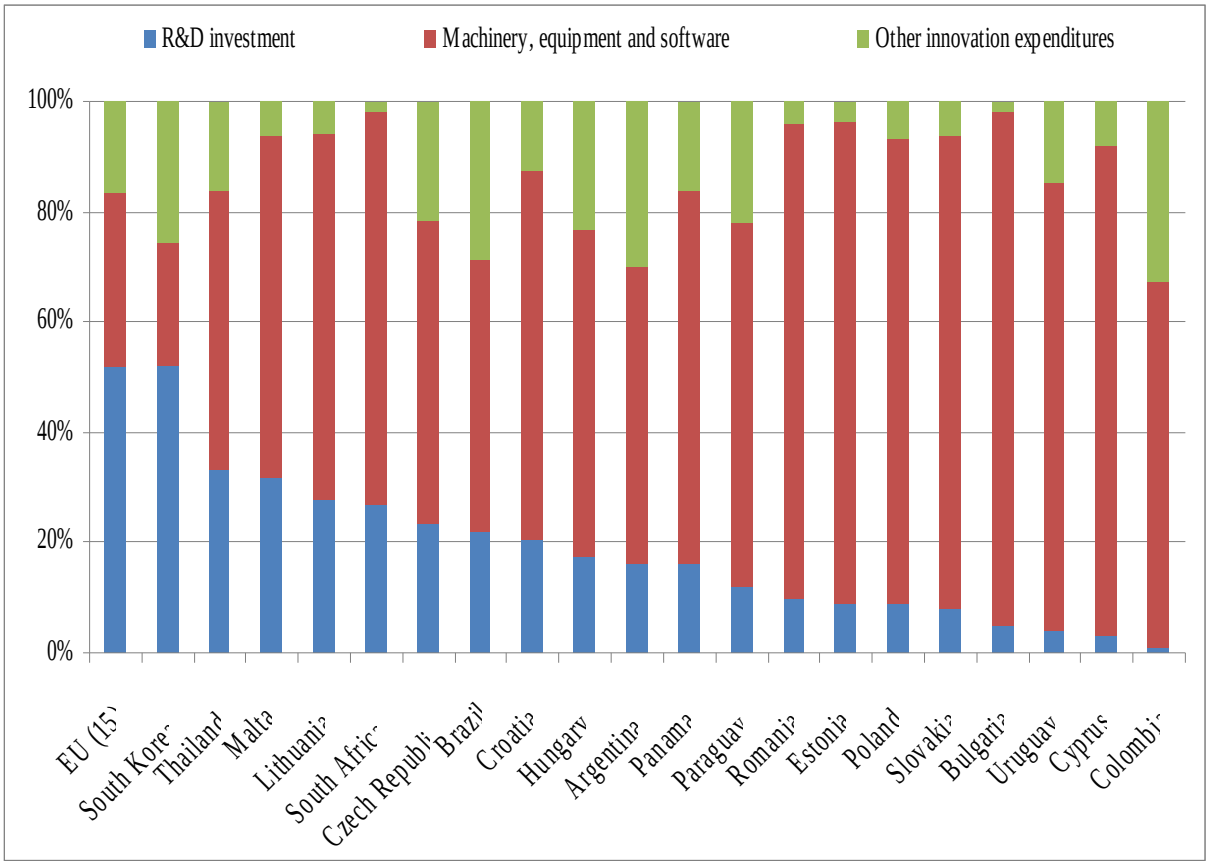
Figure 5: Collaboration in innovation activities with universities and public agencies (Manufacturing Industry)

Percent of firms in total engaged in collaboration



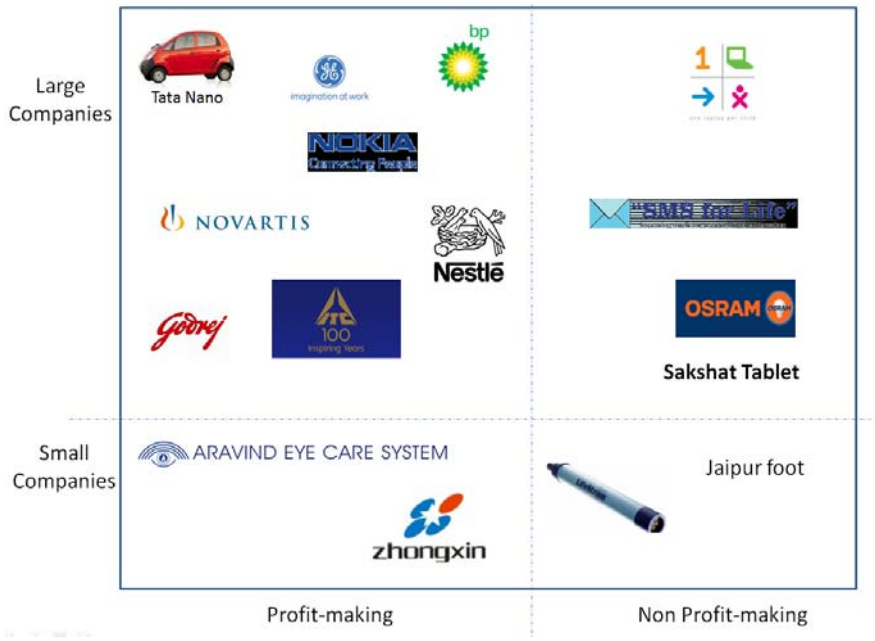
Sources: The Indicator for EU-15 countries is from Eurostat and refers to innovation surveys 2006. The indicators for Hungary, Lithuania, Latvia, Poland, Romania, Turkey, Slovakia, Estonia, Croatia and Slovenia are from Eurostat Chronos and refer to innovation surveys 2006. The survey years for other 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: 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: Categorization of different initiatives



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