Chapter 14

Open Innovation: A Research Agenda[1]

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Chandler (1977, 1990) recounts how the key technologies of the early and mid-20th century were developed by industrial research departments within the large diversified enterprises of U.S. and Europe. Such diversification, along with vertical integration from research and development through distribution, provided these firms with competitive advantage over smaller and newer rivals through economies of scale and scope.

Among these leading firms, Chesbrough (2003a) argues that the strategy brought with it a certain mindset:

> It is a view that says *successful innovation requires control.* … This paradigm counsels firms to be strongly self-reliant, because one cannot be sure of the quality, availability, and capability of others' ideas: "If you want something done right, you've got to do it yourself." (Chesbrough, 2003a: xx).

However, from his study of U.S. industry practice at the end of the 20th century, Chesbrough concluded that this model was reaching its limits. Among other factors, he identified the increased mobility of knowledge (through labor mobility) and availability of venture capital to create new firms to capitalize on such knowledge. In a parallel explanation for shifts away from the Chandlerian model, Langlois (2003a) identifies the increasing interfirm modularity and subdivision of labor (particularly in high tech industries) as obviating the need for vertical integration.

In contrast to this "Closed Innovation" model, Chesbrough argued

> Open Innovation is a paradigm that assumes that firms can and should use external and internal ideas, and internal and external paths to market. … Open Innovation combines internal and external ideas into architectures and systems whose requirements are defined by a business model. The business model utilizes both external and internal ideas to create value, while defining internal mechanisms to claim some portion of that value. (Chesbrough, 2003a: xxiv).

Based on his study of firms practicing Open Innovation, Chesbrough concluded that industrial R&D was undergoing a "paradigm shift" (in the sense of Kuhn 1962) from the closed to the open model. This is in the spirit of Donald Stokes' (1997) concept of Pasteur's quadrant, where empirical practice preceded the development of the underlying theories that later explained those practices. It also draws heavily from earlier work on industrial evolution (e.g., Nelson and Winter, 1982), absorptive capacity (Cohen and Levinthal, 1990) and the impact of spillovers on industrial R&D (Rosenberg, 1994). A more complete discussion of prior research is provided by Chesbrough (Chapter 1).

Open Innovation is both a set of practices for profiting from innovation, and also a cognitive model for creating, interpreting and researching those practices. Some of these practices are not new. For example, for more than 50 years government funding agencies and nonprofit foundations have funded scientific research, performing the role that Chesbrough (2003b) termed the "innovation benefactor."

As a new way of conceptualizing innovation, Open Innovation relaxes many of the assumptions presumed in the Chandlerian model, both in the external supply of innovation to be incorporated into a firm's offerings, as well as the potential demand outside the firm for its internal innovations. However, this does not mean that any innovation model is feasible, any more than the rise of the Internet meant that any "e-

strategy" was profitable. Experimentation within the Open Innovation paradigm has the constraint of establishing a business model for creating or using an innovation, a constraint that may have been obscured by the cross-subsidies often seen with vertical integration.

If the practice of innovation is changing because new forms of innovation are economically feasible, then this offers opportunities for researching and explaining those new practices. The Open Innovation paradigm offers propositions for how such innovation should work, and the earlier chapters in this book have identified how other examples of innovation practices fit within the Open Innovation paradigm.

However, the limited amount of empirical research since the earlier book (both inside and outside this volume) means that there are many unanswered questions about Open Innovation — and thus a concomitant number of research opportunities. To identify many of these opportunities, here we survey the potential scope of Open Innovation research, identifying both unanswered research questions and also the issues researchers will face in addressing these questions.

First we consider how Open Innovation might be studied along five different levels of analysis, and the implications of related research at each level. We then suggest ideas for research methods and data for studying Open Innovation, including ways to establish the limits and boundaries of the Open Innovation paradigm. We conclude with an invitation to other academic scholars to join in shaping and pursuing this research agenda.

Levels of Analysis

To date, most studies have examined Open Innovation at the firm level, for two reasons. First, innovation is traditionally conceived as the outcome of deliberate actions

of a single firm, and thus R&D competition has also been stylized as an innovation race between two or more firms. Second, the value of a technical invention is realized only through a business model of a firm (Chesbrough and Rosenbloom, 2002). While business models may span the boundaries of a firm or even an industry, "a particular firm is the business model's main reference point. This is why one can refer to a business model as 'firm x's business model.'" (Amit and Zott, 2001: 513-514).

However, neither the practice of nor research on Open Innovation are limited to the level of the firm. Innovations are created by individuals or groups of individuals, usually within organizations, so the sub-firm level of analysis is particularly salient in understanding the sources of innovation (cf. von Hippel, 1988). At the same time, firms are embedded in networks, industries and sectors; thus, to understand a firm's business model — particularly the value created and captured from an innovation – it is essential to consider these level of analyses. Finally, Open Innovation is practiced within the context of a given set of political and economic institutions, including regulation, intellectual property law, capital markets and industry structure. As most (but not all) of the prior research on Open Innovation has focused on the U.S. system, an examination of Open Innovation in the context of other National Systems of Innovation could more clearly identify both the prerequisites for and limits of Open Innovation, and make explicit the linkages between these institutions and practice.

To encourage future research, we now consider Open Innovation using these five levels of analysis, from the individual to the nation-state. At each level, we consider the inflows and outflows of innovation, as well as the associated policies and enabling industry practices (Table 14.1).

Individuals and Groups

Innovation begins with the efforts of one or more individuals. In the Closed Innovation paradigm, such efforts are within the firm, i.e. by company employees, and certainly such individuals play a crucial role in Open Innovation as well. Under either paradigm, firms want their R&D workers to be productive, using some combination of intrinsic and extrinsic motivations.

However, as Chesbrough (Chapter 2) notes, under Open Innovation there are the additional requirements of avoiding both "Not Invented Here" and "Not Sold Here" biases towards the creation and use of innovations. Research is needed to establish how these new requirements affect the incentives and organization of R&D workers. If firms are to be agnostic about the sources and uses of innovation, how can this be reflected in their compensation, recognition and other motivational techniques? Are other changes to the group or organizational dynamics necessary to support Open Innovation? Is hiring for Open Innovation different than for Closed Innovation, either because it requires more external scanning or because it shifts firm competencies from innovation creation towards system integration?

How are the Open Innovation challenges different for not-for-profit organizations (notably universities) that seek to motivate individuals to generate, appropriate (e.g. patent) and transfer innovations so that they have commercial value, both to the university and for private industry? If scientists differ in their activities in these areas, how much is due to individual differences in attitudes and needs, and how much is due to organizational factors such as incentives and cultural norms? In biomedical research, Zucker et al (1998) and Bercovitz and Feldman (2003) have attempted to identify some of the individual factors that motivate individuals to create and commercialize

innovations, while in their survey of Italian academic inventors, Baldini et al (2005) identify perceived impediments to such innovation. But research needs to not only explain differences in creation, but also differences in use; for example, do the interpersonal ties of academic researchers affect the use of their innovations by private industry?

In some cases, Open Innovation will also entail utilizing individuals outside the firm to supply (or apply) key innovations in the firm's business model. If these individuals are motivated using financial returns, then the issues faced by the central firm are similar in principle to those faced in dealing with innovation inflows from and outflows to corporate partners. However, there are potential search and transaction costs associated with the lack of scale — are firms used to dealing with 10 or 100 corporate innovation partners able to manage 1,000 (or 1 million) consumer innovation partners?

A potential source of innovations for many products comes from those individuals that use the product in their work or home life. Such users may innovate for their own direct utility, as has been established by the pioneering work of von Hippel (1988, 2005). Users may let their innovations go undiscovered, or may seek to profit from them; in other cases they have rational reasons for freely revealing their incremental contribution to the firm that supplied the relevant technology (von Hippel, 2005: 77-91). Research on both licensed and free spillovers from users thus is an important potential research area for Open Innovation. Research could also consider how user needs and requirements are factored into the search for external innovations — or the ways in which technology suppliers create or market such external innovations.

How can such sources of external innovation be encouraged? Prior research on user-based innovations (Franke and von Hippel, 2003; von Hippel, 2005) has shown how differences among user needs spawn user innovations, and how such innovation can be enabled through product design (such as providing "toolkits" for user innovation). But are there factors that explain the differences in the ability of firms to utilize user-generated external innovations? The lead user research (e.g. Lilien et al, 2002) has focused more on trying to establish the value of the external innovations, comparing internal and external innovations while holding firm capabilities constant.

Individual motivations are not limited to such direct economic or utilitarian gain. As West and Gallagher (Chapter 5) identify examples where software innovations are donated by individuals, often far beyond any direct utility. They point to prior research on extrinsic motivations (particularly among student users) such as external signaling of skill and availability to prospective employers. But is this a significant source of external innovations in other contexts? Or, absent direct utility, would such donations be confined to those with low opportunity cost (such as students or retirees)?

Similarly, while West and Gallagher suggest that the intrinsic satisfaction of creative expression helps attract donated innovation for role-playing computer games, are there other examples where such donations happen? Collaboration mechanisms exist for other forms of creative expression such as blogs, wikis, music sampling and cumulative creation through Creative Commons (Lessig, 2004; von Hippel, 2005). However, little if any research has been done on how such creativity is translated through a business model into commercially relevant innovations.

More broadly, the commonly cited examples of shared creativity lie within a broad class of information goods, for which the Internet and relevant software tools enable collaborative production across time and space. If such collaboration were to generalize beyond information goods, what sorts of identification, coordination and distribution mechanisms would be required? Will the necessary tools (or skills) be available to individual innovators, or only under the umbrella of firms, universities and other organizations?

Implications for Firms

The implications of the Open Innovation model for the firm were discussed at some length by Chesbrough (Chapter 2). Here we will reprise some of the most important questions identified in that chapter.

The internal, vertically integrated model of innovation from Chandler that preceded Open Innovation featured one important attribute that Open Innovation lacks. The earlier model generated many new long-term discoveries and inventions, primarily in the central R&D labs of large firms. In the Open Innovation model, it is not obvious whether such a wellspring of inventions will continue or not, because it is less clear that there will be a return to the firm's investment in those more basic research activities. If commercial firms do not realize a return on their innovative activities, they will tend to under-invest in innovative activities that are either highly risky (e.g. basic research) or that are easily imitated by free-riding competitors.

An important area of future research is thus to understand the incentives within the firm for generating the new discoveries and inventions that will supply the "seed corn" for future innovation activities. The Open Innovation model relies upon a specialization

of innovation labor (with institutions such as universities playing a more central role) and to intermediate markets (where specialist technology suppliers compete to supply new discoveries to others who commercialize them), to partially or wholly provide the seed corn for new innovation. It is an open and researchable question whether these latter mechanisms supply adequate motivation for individuals and organizations to do the hard work of discovering fundamentally new knowledge. This would include the effect on the aggregate supply of such knowledge, but also whether the new mechanisms change *which* actors are providing that supply.

Even if individual-level effects are overcome, restructuring firms to avoid the Not Invented Here syndrome directly impacts the purpose and organization of corporate R&D activities. Open Innovation subtly shifts the role of internal R&D from discovery generation as the primary activity to systems design and integration as the key function. This builds upon the recent book by Prencipe et al (2003) on systems integration, and will imply a need for changes in the norms and reward systems in most organizations.

In the Closed Innovation model, firms invested in internal R&D to create new products and services, and lived with the "spillovers" as an unintended byproduct of the process. These spillovers were regarded as a regrettable but necessary cost of doing R&D. In the Open Innovation approach, firms scan the external environment prior to initiating internal R&D work. If a technology is available from outside, the firm uses it. The firm constrains internal R&D work to focusing on technologies that are not widely available, and/or those in which the firm possesses a core advantage, and seeks advantage from constructing better systems and solutions from its technologies. A testable hypothesis from this new model is that Open Innovation firms may generate fewer

spillovers. This hypothesis, if supported, would have offsetting implications for the firm. On the one hand, fewer spillovers may mean that there is a higher yield for R&D spending, encouraging the firm to sustain its commitment to R&D. On the other hand, the lack of spillovers from other firms may deprive the firm (or the industry in which the firm competes) of organic growth opportunities for discovering future technologies.

A related question is that of time horizon for innovation activity under the Open Innovation approach. Research in the Rensselaer Polytechnic project team that studied Radical Innovation documents the long time frame and convoluted path to market of many (ultimately) successful radical innovations (Leifer et al, 2000). Open Innovation utilizes the company's business model to frame its research investments. O'Connor (Chapter 4) argues that this may shorten the time to market for more radical innovations, thus making the pursuit of radical innovation more sustainable. Would such acceleration result in more radical innovations being undertaken (which might lengthen the overall time horizon for the investments within the R&D portfolio), or would it be used to reduce the overall time spent on a portfolio of innovation? Does it imply a faster time to market for whatever R&D projects lie within the firm at any point in time? What role, if any, do longer term research investments play within the R&D portfolio of an Open Innovation-minded firm? Is Open Innovation more relevant for explorative technology projects compared to exploitative ones (March, 1991)?

A more subtle, second-order research question emerges from this potentially shorter time horizon. If projects move faster through the R&D system, does this result in more incremental innovation output? Or does a higher metabolic rate result in the faster incorporation of new knowledge, and in more (re)combinations of technologies in a given

period of time? If so, this higher metabolism of knowledge might offset to some degree the issues of overly incremental innovation and the potential loss of the seed corn research noted above. Conversely, Fabrizio (Chapter 7) suggests that as universities seek to profit from their research — rather than allowing free spillovers — both the cost and administrative overhead may slow the pace of cumulative innovation.

A third issue is the control of spillovers by firms practicing Open Innovation. Since spillovers are managed as possible sources of new revenue and new market identification and development in this model, do we see different outcomes for these spillovers? Is there a higher rate of commercialization of spillovers among firms operating within the Open Innovation paradigm? What internal barriers exist that inhibit the greater use of external paths to market for spillovers? Is there a corresponding source of inertia that parallels the Not Invented Here syndrome, as it pertains to utilizing spillovers outside the firm (that is, do internal business units seek to prevent the use of internal technologies by outside organizations, including potential competitors)?

A fourth question is, what circumstances motivate firms to embrace Open Innovation approaches as part of their R&D efforts? Is adoption of Open Innovation primarily an industry level phenomenon, or do we see significant variation in adoption within industries? If the latter, what firm characteristics are associated with differential adoption rates within an industry? Do large firms differ from small firms in their adoption of Open Innovation, as the initial work of Christensen and colleagues (forthcoming) suggests? Or do firms with relatively greater investments in internal R&D differ from those with little or no investment in R&D? Does Open Innovation provide a way for technology laggards

to close the gap with technology leaders, or will Open Innovation reinforce the specialization and scale advantages of the existing leaders?

To do such research, we would need to define what "adoption" of Open Innovation means. If vertical integration is one extreme, and the fully component model (such as diagrammed by West in Chapter 6) is the other, how would we classify the intermediate (or hybrid) strategies? If we talk about Open Innovation in terms of degree, then is there a tipping point (such as for the attitudinal and cognitive issues identified earlier)? Would we expect to see a gradual increase in Open Innovation practices over time, or (as with the adoption of other R&D best practices) a clear demarcation between the pre- and post-adoption periods?

A fifth issue turns on the management of intellectual property under Open Innovation. If firms are utilizing external technologies more frequently, they may need to engage in greater inlicensing activity. Do we see such an increase? How do firms identify potentially useful external technology sources? How do sellers manage the Arrow Information paradox[2] in offering technology to a buyer? How are the risks of technology hold-up managed in inlicensing discussions? If firms are utilizing external channels to markets for spillover technologies, how are those risks managed? Do firms change the governance of their management of IP as they engage in these transactions more frequently?

Sixth, companies that explore new (disruptive) technologies must often identify a new or adapted business model to create value (see: Amit & Zott, 2001; West and Gallagher, Chapter 5; Maula et al, Chapter 12; Vanhaverbeke and Cloodt, Chapter 13). What explains a firm's ability to identify the new business models necessary to commercialize

disruptive innovations? How is this ability developed or grown? Can it be explained by its technical knowledge or ability to get market feedback, such as through the "probe and learn" process (Lynn et al, 1996; Brown and Eisenhardt, 1998)? Can the capability be developed in isolation, or only through trial and error, developing a firm-specific model of business model development? In developing these business models, how do firms manage the conflicts between the goals of the internal business unit and the external partners?

Seventh, while previous chapters have examined inter-organizational networks, Open Innovation also increases the salience of *intra*-organizational networks. If firms vary in their ability to access and leverage external sources of technology — as suggested by Gassmann and von Zedtwitz (2002) and Laursen and Salter (2005) — it is quite likely that the heterogeneity of firms to learn and profit from these relationships is largely determined by the internal organization of these firms. To state it more directly, the effective management of externally acquired knowledge likely requires the development of complementary internal networks (Hansen, 1999; 2002; Hansen and Nohria, 2004) to assess and integrate the externally acquired knowledge. This suggests an important research area: to link the internal networks of the firm to the external use of ideas and technologies outside it. A related insight is that internal reorganization is also necessary to support the formation and sustenance of other organizational capabilities, such as corporate venturing, intrapreneurship, and creating "newstream" organizational units (Dougherty, 1995; Vanhaverbeke and Peeters, 2005).

A final very interesting question is whether the widespread use of Open Innovation would change the nature or relevance of "core competences" for firms. Christensen

(Chapter 3) argues that core competences in particular technological fields will give way to a more fluid innovation model, where firms become skilled at incorporating others' specialized technologies, rather than necessarily developing their own. A complementary view is that Open Innovation provides a much broader market for firms' core competences, enabling them to support other companies' businesses and technologies. This could make core competences more valuable, rather than less so. So Open Innovation could separate out core competencies into two broad categories: those related to creating technological innovations, and those related to sourcing or integrating such innovations.

Interorganizational Value Networks

While Open Innovation research has emphasized the activities of the firm, the innovation sourcing between (at least) two companies implies research opportunities in studying dyads of innovation partners, as well as the inter-organizational networks constructed from these dyads and the value networks associated with the value creation from a specific technology.

At the dyadic level, we would expect that the search, negotiation, contractual, implementation and support phases of Open Innovation would be better understood if researchers simultaneously captured the perspective of both the technology supplier and technology user. For example, Dushnitsky (2004) has shown that success of corporate venture capital can only be understood when the incentives of the technology start-ups are also taken into consideration. Similarly, the growth of markets for technology (selling and licensing technologies) can only be understood when the hurdles for both licensors and licensees are analyzed (Arora et al., 2001b).

There are many other potential research questions at the dyadic level. How do two companies find each other to co-develop a technology? How can this search process be improved? Among possible variables — such as transaction costs, the role of tacit or codified technology, complementary assets — which will moderate the benefits both parties see in an external technology sourcing agreement? When do start-ups see corporate venture investments not as a threat but an opportunity to grow? How do firms partners overcome their differences to build trust and a durable alliance (Simard and West, Chapter 11). How can perceived threats be managed in order to allow both technology supplier and user to profit from the Open Innovation process?

While studying Open Innovation at the dyad level would augment prior research at the firm level, research is also needed on Open Innovation in inter-organizational networks, which are more than just the sum of the component dyads. As earlier chapters have shown, researching innovation networks (both within and between networks) is essential to understanding Open Innovation, just as research on corporate innovation (within and between firms) is essential to understanding vertically integrated innovation.

The chapters of section III explicitly focus on how inter-organizational networks help explain Open Innovation, but in other chapters, the network level is implicitly present. Fabrizio (Chapter 7) shows how Open Innovation cannot be conceived without considering the networking between innovating firms on the one hand and universities and research labs on the other hand. West and Gallagher (Chapter 5) explore how communities of practitioners and firms create a symbiotic relation that leads to an explosive growth of open source software.

These chapters offer linkages between our understanding of interorganizational networks and Open Innovation, but many other topics are yet to be researched. What role do inter-organizational networks play in Open Innovation? Is the contribution of each player best explained by their competencies, roles or structural position in the network? For example, Gomes-Casseres (1996) has shown for various alliance networks in the ICT-sector that network dynamics has to be explained by the interaction of network participants with different roles, assets and value-chain positions.

If we assume the value of the network to Open Innovation, how can the focal innovator attract and coordinate all the resources necessary to bring a new, technology based product to the market? Is it necessary to manage the entire value network, or merely a small clique of central players? How is this network creation and management process different for technological discontinuities (cf. Utterback, 1994) or market-disruptive innovations (Christensen, 1997)? In either case, how does the focal firm both gain the knowledge necessary to manage the network and communicate that knowledge to the network? How does it convince potential partners to join the network during early periods of high technological and market uncertainty?

Interorganizational networks play a crucial role in the different steps of the innovation process (research, development and commercialization) as has been illustrated by the cases of systemic innovations (Maula et al, Chapter 12) and the commercialization of agbiotech breakthrough innovations (Vanhaverbeke and Cloodt, Chapter 13). At the R&D phase, how should the innovating firm select the appropriate partners? How is the selection process affected by the potentially disjoint domains of the partners' respective knowledge? In the commercialization phase, how does the focal innovator provide

adequate guarantees to partners that they will earn a return on their co-specialized assets (cf. Teece, 1986)?

Meanwhile, the firms within a value network are linked through a business model which unlocks the value latent in a technology (Chesbrough and Rosenbloom, 2002; Chesbrough, 2003a). To the degree that the innovation requires a network to realize that value, we would expect differences between networks in their realized value based on the alignment of partner activities. Prior research posits that alignment of network members is orchestrated by the firm that architects the business model (Chesbrough, 2003b; Iansiti and Levien, 2004b).

However, we do not have research comparing the effectiveness of various architectural strategies, nor the factors explaining variance in such effectiveness. Nor do we know whether alignment is explained by economic incentives provided to participants — how the value created by the network is shared among the participants — or whether variance in relational or structural aspects of network coordination also measurably affects the value realized. At the same time, any research would have to consider the focal firm's three conflicting goals of maximizing total created value, capturing value for itself and allocating value capture among the network members. To understand this, we would need to study both successes and also networks that failed in one of these three dimensions, such as networks where firms created value but failed to provide enough value to attract complementors?

Even where Open Innovation is enabled by a value network, there are questions about how that network is coordinated and maintained. What are the most important management tasks of the network orchestrator? When and how is governance shared

across the network? How do the partners manage conflict within the network, whether between competitors, buyers and sellers, or complementors? How do they overcome the threat of opportunism due to lock-in situations, investments in specialized assets and structural embeddedness?

There are also structural questions about the shape and size of these value networks. Using a biological metaphor, Iansiti and Levien (2004b) argue that certain companies play a crucial role as the keystone of a business ecosystem. But do we expect the value created (and captured) by a firm in an Open Innovation network to be completely explained by the firm's functional role in the network? Even if we assume an optimal keystone position, where in the network are the secondary opportunities for value capture — near the hub of the network, or at the rapidly evolving periphery? Where is the knowledge created by the network most readily accessible? What role does tie strength play in accessing that knowledge (cf. West and Simard, Chapter 11)? What is the optimal size and density of network evolution for value creation and innovation?

Some networks are less open to new participants than others. For example, industrial groupings such as Japan's *kigyo shudan* or Korea's *chaebol* (Fruin, 2006; Steers et al, 1989) tend to buy within their group rather than from outsiders. Hagel and Brown (2005) argue that closed networks need to become more open to develop the necessary specialization and deepening of the innovation capability of the participants. So research could test whether closed networks have performance disadvantages where specialized or deep knowledge is required, and what form of "open"-ness provides value over others. If openness has economic value, then research would also be useful to identify the levers of inter-organizational change for making an existing ecosystem more open.

Meanwhile, if companies are embedded in networks, then we would expect this to change the nature of competition between such companies: rival firms may not be competing individually but instead as part of groups of networked firms competing against other groups. In this case, the performance of companies in this setting no longer depends only on the internal capabilities of a firm but also on the overall performance of the network to which they belong (Gomes-Casseres, 1996). How does group based competition affect our understanding of Open Innovation? When considering success measures, what are the respective contributions of a firm- and network-level analysis? Should the impact of group-based competition be differentiated along different phases of the technology development — pre-competitive and competitive settings — as has been suggested by Duysters and Vanhaverbeke (1996)? How does exclusive network membership shape the dynamics of Open Innovation? Beyond obvious factors such as the costs and risk diversification of participating in multiple networks, are there other moderating factors that make exclusivity more or less attractive?

Thus, we believe Open Innovation practice will be intimately linked to how firm innovation activities are mediated networks, both inter-organizational and (as mentioned earlier) intra-organizational networks. But we also want to note the opportunities to study the impact of individual-level networks, which although they are more likely to be based on informal ties, also play a crucial role in channeling knowledge flows between firms (Simard and West, Chapter 11). Prior research has suggested that the relative importance of organizational vs. individual (and formal vs. informal) ties on of some industries (e.g. biotech with star scientists) varies based on the nature of industries or even economic regions, as with Saxenian's (1994) contrast of California and Massachusetts technology

startups. Since most Open Innovation research has focused on the firm, there remains a research opportunity to identify the antecedents and consequences of individual-level (and informal) network ties upon Open Innovation.

Industry or Sector

A more traditional level of analysis for the strategic value of innovation is the industry level. Prior innovation research has considered both the differences between the population of firms within a given industry or sector, and also the differences between industries (sectors). Because many of the intra-industry differences have been considered earlier in this chapter, here we consider to what degree differences between industries — as well as changes to a given industry over time — might affect the application of Open Innovation. We also consider the converse, how the use of Open Innovation might change the structure of one or more industries.

As a starting point, prior research has established that the nature, value and organization of innovation varies between industries and within a given industry over time. For example, it is generally accepted that during the past two decades patents and university research have played a greater role in innovation for biotechnology and pharmaceutical industries than for consumer electronics.

A common characteristic across a given industry or sector is the degree of appropriability available to firms; the role of appropriability (through intellectual property rights) in Open Innovation was the primary focus of Section II. The conventional view is that greater appropriability leads to an increased willingness of innovators to offer internal innovations for others to use (Chesbrough, 2003a; West, Chapter 6).

However, from a large scale cross-sectional study, Laursen and Salter (2005) concluded that openness was associated with a moderate level of appropriability. Meanwhile, both Fabrizio (Chapter 7) and Simcoe (Chapter 8) identify potentially negative impacts of high appropriability upon the cumulative and decentralized aspects of Open Innovation. This suggests that the relationship between appropriability and Open Innovation is more than a simple linear causal relationship, and thus further research is needed to identify potential moderators of the effect of appropriability upon Open Innovation. This might be done by a comparison of multiple industries, but could also be accomplished by comparing the same industry across multiple appropriability regimes — whether between countries, or in the same industry as it changes over time, as with the increasing use of software patents (cf. Graham and Mowery, Chapter 9).

But there are other important differences between industries that we could relate to the prevalence or nature of Open Innovation. For example, what is the relationship between R&D intensity (as a percent of sales) and Open Innovation? Are external sources of innovation more highly valued in industries with high levels of R&D? Or is external R&D more likely to be used by low R&D intensity industries where firms lack internal R&D capabilities, and thus are more dependent on external innovation suppliers?

Similarly, questions could be raised about industry concentration: the cases presented by Chesbrough (2003a) suggest that more concentrated industries are more likely to vertically integrate. However, as with the example of IBM, such industries might also have more internal innovations generated that can be outlicensed to competitors and other industry partners. Establishing the direction and magnitude of this relationship is an opportunity for empirical research.

We would also expect that other characteristics of an industry — such as stage of the technology life cycle, rate of technological change or growth — would also affect the practice of Open Innovation. The work of Zucker and Darby (1997; Zucker et al, 1998) suggested that using external innovations was a crucial mechanism for firms to deal with rapid technological change in the earliest phase of the development of biotechnologies. Would this broadly apply to other infant or rapidly changing industries, or only those directly linked to university basic research? Are there other factors that mediate or moderate the division of the innovation labor, such as the degree of technical modularity (cf. Langlois, 2003b; Sanchez, 2004) or the specialization of firms within the industry? The adoption of digital components in the audio industry support the proposition that both factors increase the use of open innovation (Christensen, Chapter 3; Christensen, Olesen and Kjær, forthcoming).

Since Caves and Porter (1977), much of our comparison of industries has focused on entry barriers, which not only play a crucial role in deterring entrants, but also enhance the sustainability of incumbents' competitive advantage (Porter, 1985). While theories of entry barriers have assumed that firms must control their own resources to enter the industry, Open Innovation can increase the number of entry alternatives and thus reduce entry barriers if it allows firms to "enter" without controlling such resources. We would predict that industries that are more "open" in their innovation patterns would also be more open to new entrants, but this has yet to be established.

Thus, Open Innovation may allow companies to come up with new business models that do not require that the orchestrating firm physically enters the industry that will be affected. For example, Amazon and E*Trade were able to enter and innovate in retailing

and financial services without investing in distribution channels, while pharmaceutical companies ship biotech products by partnering with startup specialist biotech firms, and Intel shapes and directs competition in the computer industry even though it only makes one component of the overall systems. This suggests that the availability of new business models for commercializing innovation increases the opportunities for industry entry, but how would this be incorporated into existing industry analysis tools? Do we even know enough about the creation and success of new business models to be able to anticipate when a new business model can or cannot be created?

Finally, a key point of the existing entry barrier analysis is to assess the sustainability of profits by industry incumbents. Normally, we would expect that an industry — such as one with more Open Innovation — with lower barriers to entry would also have more competitors, lower barriers to imitation and thus less sustainable competitive advantage. But is this pattern empirically supported? Or is it, as Grove (1996) argues, that an industry with vertical dis-integration allows firms to develop horizontal specializations and economies of scale that makes it more difficult for rivals to challenge the incumbents' advantages?

National Institutions and Innovation Systems

When considering how nations (and regional economic groupings such as the EU) differ in their institutional support for innovation, a key body of research is that on National Systems of Innovation, which emphasizes the importance of both *de jure* and *de facto* institutional structures (e.g., Lundvall, 1992; Nelson 1993; Mowery and Nelson, 1999). These external relationships among key actors in the system — including enterprises, universities and government research institutes — are shaped by a set of

distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process (Metcalfe, 1995). This literature suggests that both formal institutions and factors such as industry structure will affect the flows of innovation between firms.

This prior NSI research does not specifically address how national differences in such institutions impact Open Innovation. The original conception of Open Innovation presented by Chesbrough (2003a) was based on research conducted in the U.S. context. To what extent do we see Open Innovation practices in different institutional contexts, such as Europe, Japan, Brazil, or China? Is the distribution of knowledge altered by the institutional characteristics of different countries? Do we see greater or lesser use of external technologies within firms in these countries? Are there more or fewer barriers to the external utilization of spillover technologies within firms? Are intermediate markets in particular industries more or less developed in comparison to the US, and how does this greater (lesser) development influence the adoption of more open (closed) approaches to innovation? Given that the higher education sector differs markedly across the major countries, how do these differences influence the innovation process in those countries? Do we find commonalities in these different institutional settings that spur Open Innovation practices? And, if so, can we make a policy agenda to promote Open Innovation?

As discussed in the chapters of Section II, a key institution affecting Open Innovation is a nation's IP policy. The formal appropriability provided by patent and other laws will affect the incentives provided for creating and using Open Innovations (West, Chapter 6).

Over time the institutions may change, as with the U.S. decision to allow patenting of software (Graham and Mowery, Chapter 9). Nations also differ in their IP policies, so the variation of IP policies across time and national boundaries offer a potential quasi-experiment suggesting the relationship between IP policies and the practice of Open Innovation.

Other important innovation policies include government funding of innovation development, particularly the funding of public research. In most cases, such funding is direct through institutions such as the National Science Foundation or European Science Foundation, or through private institutions such as the Hughes Medical Institute or the British Heart Foundation. In the U.S., Fabrizio and Mowery (forthcoming) show that government funding plays a declining role in basic research, while Fabrizio (Chapter 7) links university efforts to profit from their research to increasing lags in firms' utilization of public science. This implies a declining availability of public subsidies as a source of external innovation, but more research needs to be done (both inside and outside the U.S.) on the impacts of such policy shifts to Open Innovation.

Perhaps more significant variation can be found in the market institutions between economies, particularly in the heterogeneous roles played by firms in an Open Innovation system. Beyond the vertically integrated closed innovation exemplar, Chesbrough (2003b) postulates eight possible roles within an Open Innovation system. They include government agencies (acting as innovation benefactors), social movements (innovation missionaries) and capital markets (innovation investors). The other remaining types of actors play different roles in the innovation value chain (Table 14.2). While Chesbrough's inductively derived classification is supported by exemplars, further

research is needed to establish whether it is mutually exclusive and exhaustive, and whether there are empirical regularities (in competencies, strategies or outcomes) between organizations within each category. Research within other innovation systems might suggest other possible roles.

The national, sub- and supra-national differences in institutions tie back to the more fundamental question of where firms should locate their innovation activities (cf. Doz et al, 2001; Iansiti and Levien, 2004b). Open Innovation defines the process by which firms access and utilize external innovations. From other research on knowledge-based geographic clusters (e.g., Audretsch, 1998; Simard and West, Chapter 11) we would expect that Open Innovation processes would also benefit from geographic co-location. While we have some research supporting such locational effects in firms accessing university innovations (Chesbrough, 2003a; Fabrizio, Chapter 7), and for knowledge spillovers between European firms in the chemicals industry (Verspagen and Schoenmakers, 2004) there remains a broad opportunity for research on how geography affects Open Innovation activities between firms.

Research Designs

Data Sources

Most of the past research about Open Innovation has been based upon case studies on individual firms or projects in the firm. More extensively, Chesbrough (2002; 2003a) offers a comparative case study based on the history of 35 technology based spin-offs from Xerox PARC. Advancing our knowledge about Open Innovation requires that researchers find new and more extensive data sources to illustrate and test different hypotheses derived from Open Innovation, and here we offer a few suggestions.

While cases have established examples of Open Innovation, additional cases could help establish the boundaries of the phenomenon. These cases could focus on particular anomalies and counterfactuals, such as why a large company is not able to generate new businesses from in-house developed technologies. Such cases could show the constraining effect that a firm's business model might have on its ability to exploit the business opportunities stemming from new technologies it developed in its R&D labs.

Cases also have a role to play in international theory development, as prior case studies have been biased towards large, US based manufacturing companies. Fragmentary evidence suggests that Open Innovation is not limited to the US and Canada but is also being practiced in Europe and Asia. The international generalizability of the what and how of Open Innovation could be empirically established through rich comparative case studies from European, Asian or Latin-American companies, considering the relationships between the differences in their National Systems of Innovation and their practice (or not) of Open Innovation. Cases could also illuminate the practice of Open Innovation that crosses national borders: for example, is Open Innovation more efficient (or likely) between countries when their cultural or geographic distance is low? How would these cross-cultural differences affect the practice of Open Innovation be implemented across national boundaries but within a multinational corporation?

Surveys are one way to dramatically expand the empirical evidence on Open Innovation. To our knowledge, no large scale survey has yet been designed to specifically analyze Open Innovation. But some existing large scale surveys can be used to analyze the Open Innovation phenomenon if the questionnaire asks respondents about the

external sources and uses of their technologies. One of the first examples of the latter was done by Laursen and Salter (2005), which analyzed responses from 2,304 manufacturing firms across the UK. The data for their analysis is drawn from the 2001 UK innovation survey, which in turn is based on the core Eurostat Community Innovation Survey (CIS) of innovation (Stockdale, 2002; DTI, 2003). Laursen and Salter (2005, p. 25) concluded that " until more research is undertaken on the evolution of search for innovation over time, the full implications of the possible movement towards 'Open Innovation' will not be fully understood."

However, there are limits to how much can be learned from existing surveys. As with any new causal mechanism, new operationalizations are needed to measure the Open Innovation constructs. One key area is in fact defining innovation, which may include activities and outputs, a narrow definition of market introduction, or a broader definition of the entire process from R&D to product introduction (Ernst, 2001; Hagedoorn and Cloodt, 2003: 1367). Which of these existing (or new) attributes of innovation are relevant to measuring Open Innovation? Should measures of innovation directly incorporate the business model, or should the business model be separately measured to explain variation in the success at commercializing a potentially valuable innovation?

Cross-sectional surveys would help to establish the prevalence of Open Innovation practices within large populations of firms. More longitudinal surveys might be designed to measure the effect of external shocks (e.g. changes in regulation). Longitudinal research may also provide evidence on the causal relationship between several concepts that are used in the innovation management literature in general and in Open Innovation in particular. Take the example of the interaction between the business model and getting

organized for Open Innovation: is a new business model the antecedent or consequence of developing relations with new external innovation partners?

Which unexplored sources to gather empirical evidence for Open Innovation are there? Fabrizio (Chapter 7) offers an example of the possible uses of patent data, but other possibilities remain. Do patent classes offer the possibility to make a distinction between explorative and exploitative patents so that one could analyze whether companies are involved in Open Innovations for exploring new technological areas rather than the exploitation of existing competencies? Can we use the geographical information in patents to explore the geographical networks among the innovation partners and how proximity might play a role in this? Patents also disclose information about inventors. Is it possible to use this data to link the practice of Open Innovation in different firms to the inter-firm mobility of star scientists or engineers, as with Rosenkopf and Almeida (2003).

Since patent citations offer different possibilities to quantify the knowledge flows between different firms, how can we use patent citations in the context of Open Innovation? Patent citation based variables have proven to be valuable constructs in the analysis of corporate venturing (Schildt et al. 2005) and R&D alliances (Katila, 2002). Given that Open Innovation defines innovation as both technical invention and a business model, how can this be captured using patent data?

Still other innovative approaches can be found in less obvious databases. E-mail exchange flows between researchers, engineers and managers of different companies that are involved in Open Innovation might bring interesting insights about knowledge flows to the surface. Similarly, product catalogs offer very detailed information about the major components contained within a complex product, providing a means to assess the

openness of companies in their product development — such as the sources of key components for a cross-section of product models. In a similar fashion, one could study the business plans (and corresponding business models) of several ventures that are financed by (corporate) venture capital funds. Does the degree of openness embodied in each plan's business model help to explain why are some ventures financed and why others not?

Another possibility is to combine several research methods. Data about patents can for instance be linked to a survey questionnaire to ask correspondents about their patent utilization within their company. This could provide us with some insights why in most companies patents lie fallow — neither used internally nor externally licensed — while other companies are more successful in exploiting their patents. In depth studies — by means of interviews — can then reveal why these companies are doing much better than the industry average.

This is meant to suggest only a few of the possible ways to execute empirical research about Open Innovation. We know that researchers will come up with many more options beyond those offered above.

Mapping the Limits of Open Innovation

The Open Innovation paradigm was identified by Chesbrough (2003a), and extended by subsequent research both in this volume and elsewhere. The prior studies (and their choice of subjects) imply but do not establish that Open Innovation is most suitable for high-technology industries where innovation plays an important role in value creation and capture.

However, such work is far from establishing the extent of the domain of Open Innovation, i.e. the boundaries between where theories of Open Innovation apply and where they do not. Identifying the limits of the paradigm is a crucial activity for both the theory of Open Innovation, and putting those theories into practice. Below are some of the areas that might be considered.

How prevalent is Open Innovation today? Where is it most often practiced? Are organizational factors that predict the use of Open Innovation related to a firm's innovation business models or rather the cognitive constraints of its scanning or integration mechanisms? Is Open Innovation really more likely in high technology firms than low technology ones, and in small entrants rather than established incumbents?

Where might Open Innovation be feasible in the future? Consistent with Teece (1986), discussions in Section II, Chapter 10 and earlier in this chapter have suggested Open Innovation depends on national institutions such as intellectual property rights as well as *de facto* appropriability regimes. But is this the only moderator of the feasibility of Open Innovation, or are there other factors at the firm, network, industry or national level that explain such suitability?

Is there a cycle of Open Innovation? Chesbrough (2003e) concludes that product and interfirm modularity increases as a technology matures, only to be reset (and supplanted by vertical integration) after a technological discontinuity. If so, then we would expect that Open Innovation would also be cyclical in a given industry.

Is Open Innovation sustainable over the long haul? As has been discussed earlier in this chapter and this volume, the ability of firms to practice Open Innovation depends on a number of factors, particularly a supply of innovations (for firms building upon

innovation inflows) and markets and appropriability for innovation (for firms seeking to profit from their outflows). Competitive advantage, industry structure, national institutions and other relevant factors change over time, so that once-successful Open Innovation strategies can eventually fail — as West (Chapter 6) argues happened to RCA's strategy of licensing its TV and radio patents. As with other forms of competitive advantage, understanding how advantages from Open Innovation are sustained may be more important than how they are created.

Under what cases does the paradigm not apply? Limits to the paradigm may be seen at either end of the spectrum. For example, Laursen and Salter (2005) found that small high-tech firms are more closed than their larger counterparts, which they explain by the firms' needs to appropriate their ideas; however, small firms may also face disadvantages of scale in searching and contracting for external innovations. At the opposite extreme, vertically integrated firms such as Samsung or Exxon continue without interruption into the 21st century, but we do not know how these counter-examples generalize to a critique of the limits of vertical integration — whether in Chesbrough (2003a), Langlois (2003a) or this volume. Similarly, while the value of vertical integration changed over time, based on the scarcity of technical and managerial skills (Langlois 2003a), conversely the value of Open Innovation might also vary over time, such that once successful models of Open Innovation could become obsolete.

Extending Beyond Innovation. The concepts of Open Innovation are anchored explicitly in the firm's success in creating and capturing value through its business model. Does this paradigm apply to other forms of value creation or capture other than innovation? Hagel & Brown (2005) argue that all value activities (not just innovation

generation) are potential candidates to get outsourced, although such normative propositions have not been empirically studied.

Conclusions

We undertook this book project because we were convinced that Open Innovation offers a new and interesting perspective to academics around the world towards understanding the processes of industrial research and development. Throughout the book, we have highlighted the many areas in which Open Innovation builds upon earlier academic work, and indicated the new contributions and emphases that Open Innovation can bring to that work. In this chapter, we have identified various areas where further research is needed, and some potential sources of data to bring insight into those areas. We acknowledge that there are limits to Open Innovation and that Open Innovation is more readily applicable in some firm or industry settings than in others, but we also recognize that what seem like limits to us may simply be research opportunities to other academic researchers.

Indeed, we do not claim to have all of the answers, or even all of the questions. What we do have is a sense that the context in which innovation occurs is evolving. Industry is changing the processes through which it innovates. Knowledge is flowing more freely and more rapidly between people and firms than ever before even though we have emphasized equally well that rent appropriation from these flows is crucial in understanding Open Innovation. The business of innovation is becoming truly global in its character, and diverse countries bring new pools of human capital and talent into play.

Accordingly, we academics must update our own understanding of the innovation process, building upon the foundations of excellent research that precedes us, and adding

to that foundation when necessary. We sincerely welcome the contributions of other academics who wish to explore these areas, for we take the task of understanding innovation quite seriously. Innovation offers society the promise of increased growth and productivity. Through these, it further offers the prospect of a high and advancing standard of living. It even offers the hope of ameliorating terrible diseases and extending the number of productive years of one's life. If Open Innovation can speed up or facilitate these innovation dynamics, understanding it better will be well worth the effort.

Because a printed book necessarily becomes obsolete at some point, we have also decided to create an online website, http://www.openinnovation.net, where interested readers can find more recent updates information on research in this area (including a comprehensive bibliography of recent research). Through the site, through meetings at the Academy of Management and other research conferences, through email and phone exchanges, and through personal networks, we hope to build an academic community around Open Innovation. Please consider this an invitation to join us!

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Tables and Figures

	Inflow	Outflow	Policies	Enabling Practices
Individual	*Creative Commons Music sampling*	Chapter 5 *Blog Open Science*		
Organizational	Chesbrough (2003) Chapters 3,4,5,12,13	Chesbrough (2003) Chapters 4,5,12	Chapter 9	Chesbrough (2003) Chapters 4,5,12
Value network	Chapters 11,12,13	Chapter 3	Chapter 8	Chesbrough (2003) Chapters 11,12,13
Industry/ Sector	Chapters 3,7,8 *Open Source Software, Pharmaceuticals*	Chapters 7, 8 *Biotech*	Chapter 9	
National Institutions	Chapters 7,8	Chapters 7,8	Chapters 6,7,9	Chapters 8, 9

Prior and *potential* research on Open Innovation

Table 14.1: A framework for classifying Open Innovation research

Phase	Role	Example	Using external innovations	Marketing internal innovations	Business Model
closed innovation	fully integrated innovators	Merck	*Uses internal innovations*	*Market own innovations*	Vertically integrated
Funding	innovation investor	Sequoia Capital	n/a	Provides capital	Financial return
	innovation benefactor	NSF	n/a	Provides capital	*None:* goal is societal welfare
Generating	innovation explorer	PARC Labs	n/a	Perform basic research	Licensing innovations
	innovation merchant	Qualcomm	n/a	Perform applied research	Licensing innovations
	innovation architect	Boeing	Source external components	Design architecture, integrate	Unique role integrating components
	innovation missionary	Free Software Foundation	n/a	Donating innovations	*None*: goal is social cause
Commercializing	innovation marketers	Pfizer	Incorporates them in product mix	Markets internal and external innovations	Market internal and external ideas
	innovation one-stop centers	IBM Global Services	Incorporates them in product mix	Markets internal and external innovations	Market internal and external ideas

Source: Adapted from Chesbrough (2003b)

Table 14.2: Innovation roles for organizations

Endnotes

[1] We appreciate the valuable feedback provided to earlier versions by Jens Frøslev Christensen, Myriam Cloodt,, Kwanghui,Lim, Wilfred Schoenmakers and Simon Wakeman..

[2] The Arrow Information paradox refers to the seller's need to disclose information about the technology to the buyer, to entice the buyer into acquiring the technology. The buyer needs to know exactly what the technology is, and what it can do. However, if the seller fully discloses all this information to the buyer during the negotiation, the buyer will have effectively acquired the technology without having to pay anything for it.