3 Open Innovation in Development: Integrating Theory and Practice across Open Science, Open Access, and Open Data

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Introduction

We know that innovation—the implementation and diffusion of new products, processes, business methods, or organizational strategies (OECD 2005, 46)—is a driver of development. Over seventy-five years of solid research proves that innovation creates jobs, generates wealth, and produces benefits for society as a whole (Arrow 1962; Marshall 1920; Rostow 1960). Innovation also has the potential to enhance individual freedom and improve people's capability to lead longer, healthier, and happier lives.

However, ensuring that the socioeconomic benefits of innovation are not concentrated among society's elites but rather are shared inclusively by all people is a significant challenge. The crucial importance of research on *inclusive* innovation has been recognized, although much work remains to be done (IDRC 2011). While the leader on inclusive innovation in recent years has been the Organisation for Economic Co-operation and Development (OECD) (OECD 2015), a number of scholars have begun to lead in the field (Altenburg 2009; Heeks, Foster, and Nugroho 2014).

Can open innovation be inclusive? Can it help unlock access to knowledge or contribute to more just, equitable, and inclusive societies? Perhaps. But, as this chapter argues, much work still must be done to align the central concept of openness applied to the phenomena of both innovation and development.

This chapter exposes and criticizes the failure of most existing research on information and communication technologies (ICTs) and open development to integrate the theories and practices of open innovation. It uses the method of meta-analysis to challenge assumptions and build an understanding of innovation across the domains of open science, open access, and open data. It brings critical insights from literature in the disciplines of law, economics, management, and public policy to bear on this problem. Finally, it considers the advantages and limitations of using the theoretical lens of open innovation to shed light on open development.

Open innovation is a useful lens for looking at open development, as the chapter concludes. Open science, open education, and open data are distinct areas where open development theories have been tested and explored. Open science, open education, and open data are also applications of open innovation models in practice. A common denominator across these various areas/applications of both open innovation and open development is the concept of access to *knowledge*. Open science, open education, and open data are all areas where knowledge flows are essential for innovation, and therefore development.

Extending Open Development Theory

Among those interested in development, open innovation is often misunderstood. It is conflated with concepts like open source, copyleft, or crowdsourcing. While such concepts may be examples of open innovation practices, the core principles of open development and open innovation are not necessarily aligned. This ambiguity and misinterpretation are emblematic of broader problems with overuse of the word *open*, which a recent review showed is associated with dozens of different terms (Pomerantz and Peek 2016). Better understanding of the relationship between open innovation and development will help grow open development beyond its roots in ICTs, in both theory and practice.

First, in theory, anchoring the concept of open development in ICTs specifically, as opposed to innovation systems more broadly, limits its potential to explain models of openness driven by socioeconomic as well as (or instead of) technological factors. A more integrated theory has wider explanatory potential and creates greater possibilities for impact.

Second, in practice, our understanding of what *open* means for development is fragmented across science, education, software, data, and other domains, despite the fact that innovation happens in all those contexts. Moreover, the focus on legal and economic formality in much existing research on these topics ignores the informality of innovation practices throughout the developing world. A more crosscutting analysis offers technologically agnostic, universally applicable, and sector-neutral insights into the concept of open development.

(Open) Innovation for Development

This section of the chapter extends the theoretical framework for open development beyond its roots in ICTs, and frames openness within the broader context of innovation management strategies and policy systems. After pushing the theory of open

development beyond information and communication technologies for development (ICT4D) to innovation systems, it may be possible to take the concept much further. Open development, for example, could critically influence fields such as information systems (Myers and Klein 2011). Once untethered from the sole domain of ICTs, open development could even shape mainstream development discourse in the way of other breakthroughs by authors such as Sen (1999) and Nussbaum (2011). Theoretical growth may start, however, with the far more modest move from ICTs to innovation.

Reilly and McMahon suggest that there is consensus emerging from open development research about what *open* means: "Open resources are defined as those which are accessible, digital, affordable, locatable, timely, sharable, and appropriately licensed. In addition, they need to be presented in a format that allows for their reuse and modification" (2015, 74). However, we know that digital resources are not accessible to many people given the levels of connectivity around the world, so conditioning open on being both accessible *and* digital does not work.

If access is about more than mere connectivity, then the temptation to characterize *open development* as being a theory formulated for ICTs, or a phenomenon driven necessarily by ICTs, creates limitations. Chapters 1 and 2 of this volume acknowledge the constraints of previous conceptualizations of open development. An early framing of open development introduced it as a set of possibilities to catalyze change through ICTs (Smith, Elder, and Emdon 2011). Smith and Reilly, leaders in the field, further suggest the idea behind open development is "harnessing the increased penetration of information and communications technologies to create new organizational forms that improve the lives of people" (2013, 4). In their foundational chapter defining open models of development, they positioned open development as an outgrowth of literature on the information society and the subsequent work on ICTs as a tool for development, so-called ICT4D (Reilly and Smith 2013). Then, in explaining the history of open models, they begin with open-source software and trace the evolution of openness from that starting point.

One possible direction is to focus on "ICT-enabled open practices" and ground theory–building in those practices (Smith 2014, sec. 1). Yet it is also possible to invert the analytical framework. ICTs may be less the tool driving social and economic reorganization than a vehicle through which social and economic changes are easily visible to community outsiders. For this, the foundational social elements, rather than technological elements, are the true drivers of information networking for innovation (de Beer and Armstrong 2015, 62).

This inverted perspective explicitly recognizes that "an ICT ecosystem is … more than just a technological system; rather, it is a social system within which ICTs are

embedded" (Smith and Elder 2010, 65). Moreover, contrary to popular belief, many or perhaps most (based on Google Scholar citations) recent uses of the term *open* do not depend on the existence of ICTs. Digitization is not a prerequisite for openness. Offline resources and processes can be open too. Of course, ICTs may be *a* factor facilitating social and economic change, but ICTs are neither sufficient nor necessary for a robust and holistic theory of open development. Smith and Seward (see chapter 2 of this volume) agree.

A technologically determined foundation for open development limits its theoretical potential. I suggest there is significant value in exploring openness outside of ICT-enabled contexts. Indeed, I believe this analytical shift is crucial to understand how openness affects development through innovation generally, beyond ICT4D. Doing so allows us to see that open models are everywhere, not just online. Without disconnecting openness from ICTs, it cannot be holistically conceived, implemented, tested, and improved as a model for development. A broader, crosscutting analysis also shows that the starting point for understanding openness is not the legal terms and conditions that govern access to software, but the social norms that inspired a community to seek out the appropriate legal tools to govern cocreated knowledge.

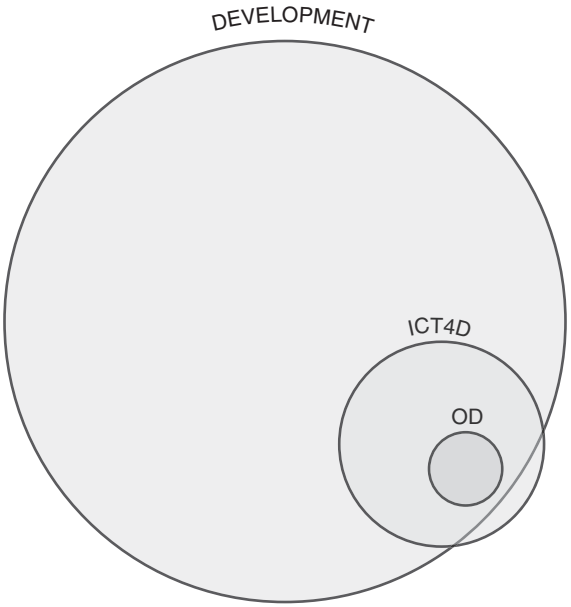

Figure 3.1
Open development (OD) conceived within the field of ICT4D.

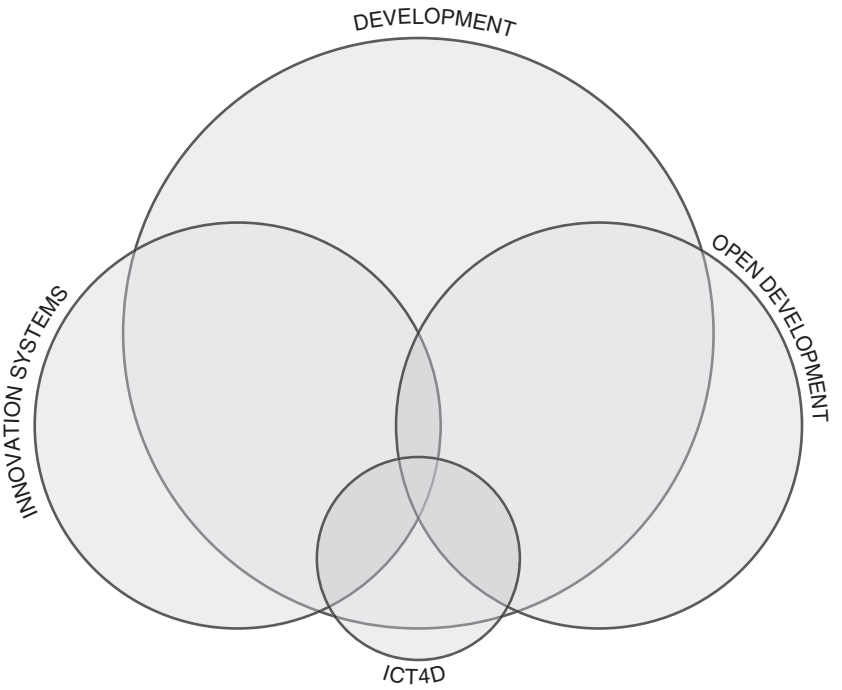

Figure 3.2
OD conceived as covering aspects of ICT4D and innovation systems.

Figures 3.1 and 3.2 demonstrate the expanded potential of reconceiving open development to cover aspects of ICTs and innovation systems, instead of a subfield or outgrowth of ICT4D research. Of course, open development might cover much more than innovation, just like innovation covers issues falling outside the concept of open development. However, enlarging the domain of open development beyond ICTs creates the possibilities of pushing the boundaries of development theory itself, as innovation systems thinking has done. Indeed, studying open development in connection with innovation systems, not just ICTs, has the added benefit of connecting the concept with a much richer body of knowledge on development generally (Lundvall 1992; Muchie, Lundvall, and Gammeltoft 2003; Kraemer-Mbula and Wamae 2010).

Furthermore, a key aspect of innovation strategy and policy that informs open development is knowledge governance. Indeed, the tension between control over and access to knowledge is a—perhaps *the*—unifying thread in open development (de Beer and Bannerman 2013). One of the most important legal tools for governing knowledge is intellectual property (IP). Laws, policies, and practices related to IP ownership can

ultimately determine who benefits from open innovation. The potential of knowledge, in particular, to contribute to development has been well theorized and documented (Aghion, David, and Foray 2009; Juma and Yee-Cheong 2005).

There are challenges to past conceptions of openness, which both this chapter and chapter 2 confront in different ways. One challenge is that there is no common theory with which to learn and compare openness across a multiplicity of connotations, applications, and interpretations. This problem is not new. From the outset of its adoption in international development, *open* has been described as a fuzzy, trendy term susceptible to co-option: "a better marketing term than analytic concept" (Smith, Elder, and Emdon 2011, iii).

Davies (2012) sheds light on one reason the idea of openness is so malleable. As he explains: "There is an important distinction to observe between openness focussed on artifacts such as data, source code, or academic articles, and openness of processes, such as democracy and development." He further comments: "Formal definitions of the former may tend to be concerned more with the legal or technical status of the artifact, whereas definitions of the latter may focus on questions of who is participating, how they are allowed to participate" (Davies 2012). Davies is among numerous researchers who suggest that openness is often defined in oppositional terms. In the legal context, for example, *open* is the opposite of *proprietary* (Reilly and Smith 2013, 31). A question to answer using a more integrated theoretical framework, therefore, is: How might the relationship between open, proprietary, and blended models of innovation enlighten us on what open development is or is not?

Another challenge, also identified in chapter 2, is that openness is typically defined in universal legal and technical terms that are not sufficient for understanding the reality of openness in a development context. While the inclusion of some legal criteria is common across the openness discourse in various domains (Smith 2014, sec. 2.2), just saying that open resources are those that are *appropriately* licensed is too vague to be meaningful. Indeed, there are valid concerns about whether any kind of legal licensing requirement must be part of a definition of open. "[S]coping the concept of openness as legal permissions is an arbitrary boundary that doesn't reflect reality," explains Smith (2016, 6–7). That is because, as explained later in this chapter, legal rules may be less influential than social norms governing the appropriation of and access to knowledge in many developing countries. Smith's point about the arbitrariness of scoping openness through legal permissions, echoed in chapter 2, mirrors my previous point about the limitations of a technologically determined definition.

In the broader context of innovation systems, "the link between openness and innovation is not necessarily straightforward; openness may support some types of

innovation, but there can be a dynamic and productive tension between open and enclosed systems. Closed technological innovations can often emerge from open systems, while open initiatives can take advantage of closed technologies or systems" (Reilly and Smith 2013, 35). Researchers have investigated whether open innovation might change innovation policymaking in catch-up economies (Karo and Kattel 2011), but they have not situated open innovation in the context of development policy more generally.

Significant uncertainty stems from the fact that many development scholars' understanding of openness is inconsistent with the literature on open innovation, especially with respect to knowledge governance systems. This discussion now turns to the open innovation literature.

Innovation through Openness

The open innovation literature is vast and well established. Numerous thorough reviews and syntheses of key sources among the thousands of works on this topic have already been published (e.g., Chesbrough and Bogers 2014; Dahlander and Gann 2010; Elmquist, Fredberg, and Ollila 2009; Fredberg et al. 2010; Huizingh 2011; Lichtenthaler 2011; Van de Vrande, Vanhaverbeke, and Gassmann 2010; West et al. 2014).

If another open *anything* movement is to move forward with credibility in the fields of innovation studies, management science, law, or economics, then a serious conceptual gap must be acknowledged and bridged. This is especially true with respect to open business models, where the focus is squarely on firm strategy, but the leading research is neglected (compare Mizukami and Lemos 2010 with Chesbrough 2006 and Teece 2010).

While there may be observable differences between developed and developing countries, such work should not continue in silos. It is impossible to be taken seriously by the business leaders or economic policymakers whom development researchers aim to influence without understanding the perceived connotation of terms like *openness* and *innovation*. The research gap is not just about North versus South or developed versus developing country; it is also cross-disciplinary and cross-sector. This subsection of the article summarizes the most relevant insights for open development.

"Open, user, collaborative, and related innovation concepts imply strategies and systems where ideas and knowledge flow across firm boundaries" (de Beer 2015, 11); that is the common thread in the literature on openness related to innovation. Beyond that point of convergence, however, a recent review by leading researchers identifies a "fault line" over the importance of appropriation (West et al. 2014, 808). The key divergence concerns how and why knowledge spillovers happen.

Research on user innovation, grounded in the work of Eric von Hippel, tends to view appropriation through IP rights as a drag on innovation, especially sequential or cumulative innovation, thus diminishing social welfare (von Hippel 2005). In this context, the word *open* is adopted as part of the phrase *open collaborative innovation* to mean "all information related to the innovation is a public good—non-rivalrous and non-excludable" (Baldwin and von Hippel 2011, 1400). The nonproprietary *innovation* is open.

Research on *open innovation*, a term associated with Henry Chesbrough's seminal book of that title, sees the appropriation enabled by IP as a tool facilitating inflows and outflows of knowledge between businesses (Chesbrough 2003). Recent work on open innovation by West et al. (2014, 806) has defined the phenomenon as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms." Chesbrough's first book has been cited almost 12,000 times, with subsequent related works being cited thousands more times.

It may surprise open development researchers to realize that within the most widely known and cited paradigm of open innovation, strong IP protection is a key facilitator of openness. That is because the openness that Chesbrough identifies is the firm's; in the process of innovation, the knowledge-exchanging firm, but not necessarily the knowledge, is open.

There is a parallel between the system's/firm's views of openness in innovation and the artifact/process distinctions of openness in development. Research following von Hippel's work on open and collaborative innovation centers on the open nature of the artifacts circulating within an innovation system. Research following Chesbrough's work on open innovation and open business models centers on the open nature of processes through which firms innovate.

From the firm-centric perspective, clearly delineated IP rights that can be purchased or sold by a business are among the important market institutions that explain the rise of open innovation during the second half of the twentieth century. The existing research on open innovation highlights several major trends driving the phenomenon: market institutions, labor mobility, product complexity, and technology platforms (de Beer 2015, 20).

Market institutions other than IP that promote open innovation include venture capital, securities exchanges, and other financing systems, as well as industry standards that require interoperability. Labor mobility is a crucial factor, as people no longer spend entire careers with one organization. As people move, so does knowledge. Increasing product complexity is also associated with open innovation because no

single firm is able to produce all components working in isolation. Finally, technology platforms—ICTs in particular—make asynchronous collaboration across geographic boundaries possible. Technology is one (but not the only) factor responsible for open innovation, which is noteworthy for open development.

Much of open development research has seized upon only part of the literature on openness and innovation. Benkler's concept of *peer production*—decentralized, collaborative, nonproprietary production by widely distributed and loosely connected individuals (Benkler 2006)—has been the most influential (IDRC 2011; Reilly and Smith 2013; Smith and Elder 2010; Smith, Elder, and Emdon 2011). Regarding appropriation (or, rather, nonproprietary) approaches to knowledge management, Benkler's conceptual framework is more closely aligned with von Hippel's work on user innovation and open and collaborative innovation systems than with work on open innovation in the firm-centric paradigm (de Beer 2015, 28). A key question that this chapter raises is whether widely distributed and loosely connected peer production aptly characterizes much innovation that happens in the informal sector, which dominates economic activity throughout developing countries.

A "Source" of Openness to Interpretation

Other influential concepts imported into open development research include crowdsourcing and open sourcing, ideas that offer insights into the root causes of misunderstandings. Despite sharing the common word *source*, these terms cover very different ideas. Applying the various perspectives of open innovation/collaborative innovation/peer production to specific examples and applications, such as crowdsourcing and open-source software, illustrates the challenges and opportunities of integrating innovation into open development theory and practice.

Crowdsourcing is a term coined by Jeff Howe, first in an article for *Wired* magazine and then in a book by that title (Howe 2006; Howe 2008). A cross-disciplinary review of research later integrated forty original definitions, from over 200 sources, to propose this integrated definition: "Crowdsourcing is a type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task" (Estellés-Arolas and González-Ladrón-de-Guevara 2012, 197).

With their integrated definition, Estellés-Arolas and González-Ladrón-de-Guevara (2012, 197) offer eight criteria to determine whether an activity is crowdsourcing or not:

"(a) there is a clearly defined crowd;
(b) there exists a task with a clear goal;
(c) the recompense received by the crowd is clear;
(d) the crowdsourcer is clearly identified;
(e) the compensation to be received by the crowdsourcer is clearly defined;
(f) it is an online assigned process of participative type;
(g) it uses an open call of variable extent;
(h) it uses the Internet."

Two things are notable about the integrated definition of and criteria for crowdsourcing. First, it is not always easy to delineate the boundaries between crowdsourcing as a form of firm-driven open innovation on one hand and open/collaborative/free peer production on the other. Take Wikipedia, for example, which in some ways seems like a form of crowdsourcing and in others seems like peer production. While there is a clear goal to create a free, publicly editable encyclopedia, via an online process involving an open (implicit and sometimes explicit) call to participate on an Internet platform owned and controlled by the nonprofit Wikimedia Foundation, there is no clearly defined recompense, at least not in the form of pecuniary compensation. Wikipedia meets more than half, but not all, of the eight characteristics of crowdsourcing. Open development researchers may conceive of Wikipedia not as crowdsourcing, but rather as a mode of peer production, in the sense imagined by Benkler. However, scholars in other fields may see it as a firm-centric open innovation strategy within Chesbrough's open innovation framework. Ambiguities about crowdsourcing demonstrate differences between certain conceptions of peer production and open innovation, and thus raise questions for open development researchers.

Second, several of the eight elements that describe crowdsourcing seem difficult to apply in the context of informal economic activities in the developing world. In particular, much open innovation in the informal economy happens offline in social, not technological networks (de Beer and Armstrong 2015; Kraemer-Mbula and Wunsch-Vincent 2016). Moreover, the firm-centric understanding of crowdsourcing presupposes a degree of order and organization that may not be easily observable in the informal sector. This contrasts with certain kinds of crowdsourcing, such as solutions-sourcing, in the formal sector of developed countries where topics like IP management are more easily studied (de Beer et al. 2017). Thus, is crowdsourcing a misnomer in open development, or is international development missing in the research on crowdsourcing?

Open source is often understood as the inspiration for open development through ICTs. Open-source software is a better example of peer production than crowdsourcing,

although many firms practicing crowdsourcing may turn to open-source solutions. The original and still-leading research explains that *open source* refers to software licensed on particular terms. The license must meet the criteria for free redistribution, source code availability, and derivative works, among others (de Beer 2015; Perens 1999; Raymond 1999).

One key point is that, in the context of software, *open source* is defined primarily in reference to legal criteria. But another key point is that open-source software is *not*, legally speaking, nonproprietary. It is legally protected by copyright, patents, or both, but creatively licensed to require, instead of restrict, sharing (de Beer 2015, 32). A framework is also emerging to understand open-source hardware, in addition to software, based on similar legal principles and practices.

Chapter 2 classifies crowdsourcing as a contribution that the open innovation school of thought has contributed to an overarching framework for open development. It also positions open-source software as the school of thought that contributes ideas about peer production, open licensing, and user freedom. While crowdsourcing is one example of open innovation, and software is the most dominant model for understanding openness in ICT4D, this chapter argues that looking across other domains through the lens of innovation is appropriate to frame open development. The next section of this chapter, therefore, considers the relationships among innovation, appropriation, and development in the realm of open science, open access, and open data.

A Crosscutting Concept of Openness through Innovation in Practice

Both scholarly literature and practical experience belie the premise of classifying the study of innovation, business models, or both into a silo distinct from the domains of science, education, or data. Indeed, open innovation is inseparable from open science, open education, or open data. Through access to and exchanges of knowledge, innovation is intractably embedded in, and also transcends, each of these fields. The implementation and diffusion of new products, processes, and organizational and marketing methods (i.e., innovation as commonly understood) are the phenomena that make science, education, and data drive development in a knowledge society. Figure 3.3 depicts these relationships.

Therefore, this section of the chapter considers innovation-related aspects of knowledge governance across domains ranging from science to education to data. It takes up the challenge to move "beyond studying the qualities of openness within specific localized projects, and focus its energies on crosscutting studies that identify the factors driving quality openness" (Reilly and McMahon 2015, 48). It starts with an overview of open access, which straddles open innovation and each of the three focal areas

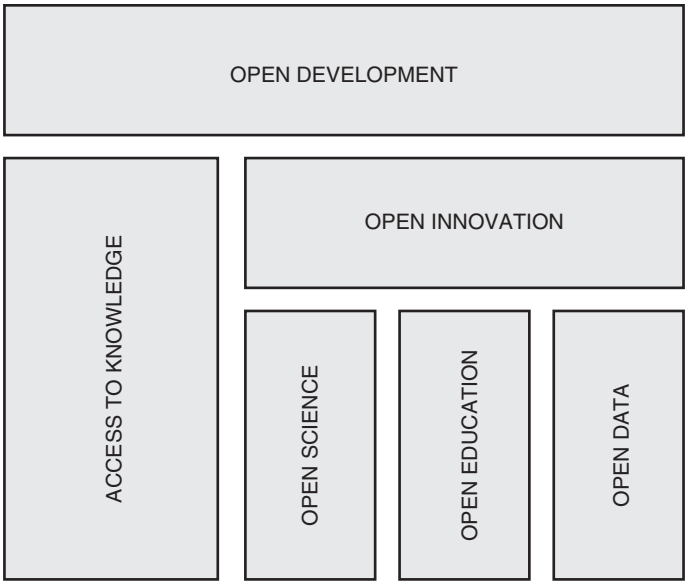

Figure 3.3
A framework for analyzing openness, situating knowledge and innovation (not ICTs) among science, education, data, and development outcomes.

of education, data, and science most closely connected with the concept of access to knowledge as a whole, which straddles open innovation and each of the three focal areas of science/education/data.

Open Access

Most definitions of openness include accessibility as a core feature. The term *open access* is related to, but not synonymous with, the concepts of open science, open data, and other applications of openness. It generally refers to published content that is digital, online, free of charge, and free of most copyright restrictions (Suber 2012). These freedoms address two separate barriers to accessibility. Making works available *gratis* removes financial barriers to access, while making works available *libre* removes permission barriers to access.

Both of these freedoms were emphasized in three formal declarations on open access publishing: the Budapest Open Access Initiative (Chan et al. 2002), the Bethesda Statement on Open Access Publishing (Stebbins 2003), and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (Max-Planek-Gesellschaft 2003).

A common theme is the understanding that: "[f]or a work to be OA [open access], the copyright holder must consent in advance to let users 'copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship'" (Suber 2012, 8).

More so than open science, the term *open access* has long been associated with IP licensing, particularly copyrights. Imbued with this legal connotation, open access has since evolved in three related but distinct directions. First, the original issue of access to published scholarly literature continues to generate debate. Second, recent innovations have led to an increased use of open access to publish other types of content. Third, open access is moving to educational resources, both in artifacts and the process of learning.

In the first area, open access to scholarly literature, one of the strongest arguments for open access to literature is its potential to increase the impact of scholarly publications (Hess and Ostrom 2003). Early research suggested that journal articles received more citations when openly published (Antelman 2004; Eysenbach 2006). These findings generated significant interest within academia, leading to the "green and golden roads to open access" (Harnad et al. 2004, 310). By 2004, 90 percent of academic journals surveyed in one study were "green"—that is, they allowed authors to self-archive—while 5 percent of academic journals were "gold," which means publishing under open access licenses (Harnad et al. 2004, 313). More critical reviews call these impact effects into question, pointing to variability in findings and identifying various biases (Craig et al. 2007). However, a strong consensus remains that open access increases academic impact (Tennant et al. 2016).

The demand for open access to literature has never been higher. Elsevier's recent legal victory drew attention to the academic piracy site Sci-Hub, whose users downloaded 28 million papers between September 2015 and March 2016 (Bohannon 2016). However, limited research examines the economic impacts of open access to literature. A report to the United Kingdom's Open Access Implementation Group estimated that open access saves the public sector £26 million in access fees and £2.6 million in time (Look and Marsh 2012). Recognizing the economic and social value of open access literature, the Barack Obama administration announced in 2013 that federally funded research in the United States would be freely available within one year of publication (Stebbins 2013).

Second, as Internet bandwidth has increased, so have "remix culture" and the demand for freely available content (Lessig 2004, 965). The Creative Commons (CC) suite of copyright licenses has helped to meet this demand, allowing creators to publish their works gratis while selecting a range of libre-based requirements for attribution and use.[1] Over 1.4 billion works are openly accessible under CC licenses (Merkley

2018). Major Internet services offer options to publish under CC, including content on Wikipedia, video on YouTube, music on Soundcloud, and images on Flickr.

Open Education

Third, open access to educational resources has moved beyond textbooks and other content-based artifacts of education, to the process of learning. Educational resources are made open with the understanding that "access to the world's knowledge is a public good" (Smith and Casserly 2006, 10). Research in the field explores how open educational resources (OER) are produced, delivered (Wiley, Bliss, and McEwen 2014), and adopted, as well as their subsequent impacts (also see chapter 12 for more on OER). OER include open courses and learning materials, software for learning (e.g., learning management platforms), and repositories of learning materials (Downes 2007).

Downes (2007) highlights a number of business models being used to provide OER. Models include an endowment model, where funding comes from interest generated from large donations (e.g., Stanford's *Encyclopedia of Philosophy*); an institutional model, where funding is part of the organization's operational budget [e.g., the Open Courseware program at the Massachusetts Institute of Technology (MIT)]; and a conversion model, where for-profit organizations offer *freemium* options, with the goal of converting free consumers into paying customers (e.g., Coursera) (Downes 2007). Some governments have shifted spending from proprietary to open resources.

In terms of access to the *process* of education, massive open online courses (MOOCs) have emerged as particularly interesting (Haggard et al. 2013). These online courses are open for anyone to enroll in and access reading lists, lectures, and various learning experiences. Examples include edX, run by a consortium of universities including Harvard, the University of California, Berkeley, and the University of Adelaide; Coursera, run by Stanford, Princeton, and Arizona State University; and Udemy, a nonacademic skills training site that allows experts to create and administer courses.

As with OER, MOOCs have struggled to find sustainable business models (Wiley, Bliss, and McEwen 2014), although there are some emerging models such as charging for specializations, on-demand MOOCs, and verified certificates (Tirthali 2016). What is clear is that the development and maintenance of online learning materials are costly. For example, each course published on MIT's Open Courseware takes a minimum of 100 hours of effort to produce, at an annual cost of US$3.5 million.[2] The costs to produce and deliver MOOCs can also be quite high. A 2014 study found that the cost per course for MOOCs ranged between US$38,980 and US$325,330 (Hollands and Tirthali 2014), and a more recent paper noted that there are examples of high-end

courses costing up to an estimated US$1 million (Tirthali 2016). These costs highlight the challenges that providers face in covering their costs while maintaining free access to course materials.

A number of other governance challenges exist for MOOCs. Although free, as in gratis, remains a common theme across MOOCs, now many courses are not offered free, as in libre. The debate about whether these courses are *massive, open,* and *online* or just *massive* and *online* demonstrates the ambiguity and controversy about what *open* really means. These developments have led some commentators to speculate whether massive online courses can remain free and sustainable (Tirthali 2016; Gee 2016).

Open access to both educational resources and processes is especially important for developing countries, as IDRC-supported research on open development clearly demonstrated (Armstrong et al. 2010). In the knowledge economy, access to information drives innovation and growth. Limited financial resources within developing countries constrain access to proprietary journals and other creative resources that are necessary for innovation. Education for innovation requires access to both materials and pedagogical tools for learning. As emerging concepts that require innovation in their implementation, open access and OER will also create opportunities for education in the process of innovation.

Moving forward, a leading thinker on OER forcefully argued that there is no longer any debate about the meaning of *open* in the context of OER: "As far as I can tell, the only people actively engaged in a debate about the meaning of the word 'open' in the educational context are (1) those who genuinely misunderstand it because they haven't become part of the community yet, and (2) those whose business models would collapse if the public had free access to and open licenses for their products" (Wiley 2016). The key phrase in Wiley's comment is "in the educational context."

Cutting across sectors—looking at innovation in education, science, data, and other areas—there is significant debate about what *open* really means. When organizations around the world say that they practice open innovation, it is not just naivete, or "openwashing" as Wiley suggests (Wiley 2016). These organizations may be adopting a bona fide understanding of openness based on renowned work by authors such as Henry Chesbrough. Work in the realm of open data helps to further highlight the conceptual challenges that still plague open development across domains.

Open Data

Data have become valuable with the rise of the digital era, informing and driving scientific discovery, underpinning business models, and supporting evidence-based

policy. Developments in linked data provide incentives for firms to open their data for collaboration.

The *Open Data Handbook* (n.d.) defines "data" as data sets as opposed to a single data point, which it defines as "content". Data are considered to be "open" when they can be accessed, used, modified, or shared by anyone (*Open Data Handbook* n.d.). Within the open innovation literature, there is some consensus that open data require ICT—the data must be machine readable and accessible online (Chan 2013; Gurstein 2011). In contrast, open development scholars acknowledge that data take many qualitative forms, including maps, pictures, and paintings, and need not be machine readable or accessible online to be open (Hossain, Dwivedi, and Rana 2015; van Schalkwyk et al. 2014).

As an intangible resource, IP governs the ownership of data. By default, owners hold a proprietary right to their data. This is a result of a combination of legal mechanisms governing ownership of data, including copyright, sui generis database rights, technological protection measures (TPMs), trade secrets, and privacy (de Beer 2016). Copyright (the most commonly discussed mechanism) automatically protects original compilations of data in databases, but not fact-based content like statistics or formulas. More than one of these legal mechanisms may apply to a given data set, increasing the ambiguity of data ownership. Therefore, data are only considered "open" when they are published under an open license.

Proprietary ownership of data poses several challenges for open data artifacts. In practice, proprietary data hinder the growth of the linked data commons, making it impossible to apply open licenses to linked data sets containing proprietary data. The ambiguous nature of ownership rights in data means that licensing open data may not be as straightforward as other content. Conversely, clearer ownership rights could facilitate open data by enabling owners to apply open licenses to their data. Open data licenses transfer these rights, allowing anyone to access and use the data with attribution and other optional conditions (Open Data Commons n.d.; Creative Commons 2013).

Despite the challenges, firms are practicing open innovation by releasing their private data, recognizing the economic benefits and potential of open data systems (Dodds et al. 2014; Hammell et al. 2012; Open Data Institute 2016). Depending on the particular model adopted to share open data, these practices could reflect either the firm-centric version of open innovation, by using IP licenses to exchange data into and out of the organization, or a more systemic approach, in which data are put into the public domain without any IP protection at all. In either case, the economic impacts of open data are substantial.

It has been suggested that the market impact of public-sector information across the European Union (EU) in 2008 was €28 billion (Vickery 2011). An independent review

in the United Kingdom estimated benefits of public-sector information at £6.8 billion in 2013 (Shakespeare 2013). Looking globally across public- and private-sector information, the McKinsey Institute estimates the widespread use of open data will globally unlock $3.2 trillion in economic value per year (Manyika et al. 2013). However, it is difficult to assess the reliability of these figures because little or no empirical work has been conducted on the macroeconomic impacts of open data.

Using business case studies, the Open Data Institute (2016) describes how three firms, Thomson Reuters, Arup, and Syngenta, have adopted an open data approach to gain an economic and competitive advantage. Thomson Reuters opened access to Permanent Identification (PermID), its key entities identifier system, to improve the richness and accuracy of their data (Dodds et al. 2014). They enjoy a reciprocal benefit when outside users link their open data to the PermID system, gaining access to outside data with little additional effort (Dodds et al. 2014). Arup, a design and engineering consulting firm, uses open data to enable nimble responses to new ideas inside and outside the organization. It allows Arup to "create IP without having to have complex legal agreements, lawyers, and background discussion that slows everything down" (Open Data Institute 2016). Syngenta, a global agricultural firm, has published six open data sets as part of their Good Growth Plan for sustainably growing their business by improving global food security (Open Data Institute 2016). Beginning as a strategy to engage stakeholders and build trust in their plan through transparency, Syngenta AG view open data as part of a shift toward a more collaborative business model.

There is considerable optimism surrounding open data among the development community. The World Bank sees their potential to help level the playing field for the communication of knowledge (Walji 2011). Such inclusivity is expected to generate more effective outcomes (Davies and Edwards 2012). For example, increased access to information allows policymakers and aid funding agencies to make evidence-based decisions (Linders 2013). But scholars warn that "openness must serve the interests of marginalised and poor people" (Davies and Edwards 2012), which in many cases is overlooked and has only a tangential bearing on the open data work being done.

Several challenges must be overcome before these opportunities are realized. Unequal access to ICT and open data creates a digital divide, excluding marginalized users from the benefits of open data while empowering users who already have expertise and access (Gurstein 2011). Developing countries and businesses often lack the capacity to digitize their data (Davies 2014).

When open data are available, they are often published in the aggregate (for a variety of reasons, including privacy). But the developing world needs disaggregated data to make evidence-based policy decisions (Addison et al. 2016; Chan 2013). Data

intermediaries are recognized as part of the solution to these challenges (van Schalkwyk et al. 2014), but more work is needed to increase ICT penetration and address the context of developing countries. (See chapters 10 and 11 in this volume for more on open government data.)

Open Science

Science is perhaps the broadest domain for open development research because it both produces and depends on scholarly literature and data. In a way, open science subsumes and transcends many aspects of open access publishing and open data (although, as chapter 13 in this volume suggests, open science may be interpreted differently in the context of development). It may be reasonable to treat certain open access issues, such as access to scholarly literature, primarily under the rubric of open science. The framework offered in this chapter, however, considers scholarly publishing alongside other forms of open access that share common roots (specifically, access to remixed cultural content and access to educational resources). Open science has different and earlier historical roots.

Dasgupta and David (1994, 487) explain the "new economics of science" as a synthesis of "the classic approach of Arrow and Nelson in examining the implications of the characteristics of information for allocative efficiency in research activities, on the one hand, with the functionalist analysis of institutional structures, reward systems, and behavioral norms of 'open science' communities—associated with the sociology of science in the tradition of Merton—on the other." The stylized term inspired by Merton (1973), *open science*, is now understood as being an institution with a self-reinforcing code of conduct. The scientific priority of original discovery is rewarded with monetary and social benefits, which create incentives for full disclosure and diffusion of scientific knowledge.

The open science model contrasts with one where exclusivity of property rights is the key incentive for investments in science. The tension over openness was described by Paul David and Bronwyn Hall (2006, 767) in this way, in the introduction to a special issue of *Research Policy* on IP issues affecting science: "[W]e have two distinctive regimes or environments for the conduct of research: the actors in the realm of 'open science research' expect reciprocal sharing of discoveries among themselves and the rest of the world, while those in the world of private profit-oriented and proprietary R&D expect to receive payment for the right to use their inventions (and to pay others for the use of theirs)." This and other seminal literature on open science define *openness* at least partly by reference to its opposite, *proprietary science* (see also David 2004). For more details, see chapter 13 in this volume.

The incentives produced by open and proprietary approaches have different impacts, depending on the system in which science operates. Indeed, it has been shown that open science contributes to scientific and economic inequalities in developed and developing countries (Carillo and Papagni 2014; also see chapter 13). That is because the larger the scientific system in terms of investments and involvement of the state in which one operates, the greater the social and professional rewards for openness tend to be. There are fewer rewards in smaller systems characterized by scant investments. Consequently, economic modeling shows a world with two stable equilibria, which "may explain the huge differences existing between scientific sectors of less developed and more developed countries" (Carillo and Papagni 2014, 52).

Distinctions between open and proprietary models of science had roughly tracked the divide between university- and industry-led processes. But this line is becoming increasingly blurry as universities face pressure to commercialize scientific research and industry experiments with new appropriation strategies that support more open models of innovation. IP rights play a central role here. One of the key conclusions flowing from leading research on academic science and entrepreneurship is that IP rights such as patents are "changing the 'rules of the game' for scientific exchange, scientific credit, and the commercialization opportunities arising from scientific discovery" (Jaffe et al. 2007, 575).

The most significant shift in academic entrepreneurship during the twentieth century occurred as a result of legislation in the United States, the Bayh-Dole Act, which permitted recipients of public funding to obtain private IP rights over research outputs. While the legislation, passed in 1980, may not have fundamentally changed processes at the few American universities that were already actively exploiting IP (Mowery et al. 2001), for most institutions the Bayh-Dole Act was "a major impetus towards increased university involvement in patenting and licensing" (Sampat 2006, 781; also see Berman 2008, 836–837). Indeed, Bayh-Dole is associated not just with increased IP awareness and acquisition, but with academic entrepreneurship more generally (Aldridge and Audretsch 2011; Grimaldi et al. 2011).

"[T]he intellectual foundations for this sea-change in federal patent policy were weak," explains Sampat (2006, 773), "based on a lack of understanding of the roles of universities in the innovation system." Nevertheless, in the early twenty-first century, the impacts of the Bayh-Dole Act, combined with the World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), have been rippling throughout the developing world. In a must-read review of economic evidence pertaining to IP's impact on science and technology in developing countries, Forero-Pineda (2006, 810) summarizes: "Scientific communities in developing countries are particularly vulnerable to limitations of cooperation and access to information,

resulting from stronger intellectual property rights protection, as their efforts to obtain normal science results must be considerable."

There are basically two ways in which IP threatens open science: access costs and transaction costs (David 2004). Institutional innovations that privatize and commodify knowledge "have a potential to do serious damage in the field of scientific and technological research, with all the adverse implications that this may carry for the long-term course of innovation and economic welfare growth in the advanced, 'knowledge-driven' economies and the developing economies alike" (David 2004, 10). Empirical studies, using methods such as difference-in-differences estimators, show substantial benefits of academic openness for innovation (Murray et al. 2016). Economic modelling also shows that under the right conditions, open science is associated with higher social welfare than secrecy (Mukherjee and Stern 2009).

In developed countries, a possible "tragedy of the anti-commons" is among the biggest concerns around the push to propertize and commercialize scientific research (Heller and Eisenberg 1998). Empirical research is scarce, but some evidence shows that patents do have a "modest anti-commons effect" that hinders the free flow of scientific knowledge (Murray and Stern 2007, 649). A core challenge is developing an empirical methodological framework to test anti-commons and open science theories. This is very difficult in developed countries with data about patents and publications (Murray and Stern 2007, 656–661). It is even more difficult to conduct quantitative or statistical analysis in developing countries, where new concepts and metrics to measure informal innovation are just beginning to emerge (de Beer, Fu, and Wunsch-Vincent 2013).

Numerous researchers have called for reform of the Bayh-Dole system in the United States (Kenney and Patton 2009; Rai and Eisenberg 2003). There is also significant debate on whether the Bayh-Dole approach is appropriate for other developed countries. The most credible research suggests not: "efforts at 'emulation' of the Bayh-Dole policy elsewhere in the OECD are likely to have modest success at best without greater attention to the underlying structural differences among the higher education systems of these nations" (Mowery and Sampat 2005, 117). The problem is even worse when transplanting Bayh-Dole to developing countries (So et al. 2008, 262).

It is not surprising, therefore, that the emerging research on open science in development characterizes the issues very differently. Development-related research on open science frames the issues less in economic terms than as about "the ways in which colonial legacies, capitalist forces, and political repression continue to limit access to knowledge around the world" (Albornoz 2016, sec. 1).

While it is justifiably argued that "Open Science addresses development by expanding opportunities to create, share, and use knowledge" (Albornoz 2016), these are unfortunately not the terms on which policy debates are unfolding in real time in developing

countries. New research by the Open African Innovation Research (Open AIR) network demonstrates that open science is under threat as a result of Bayh-Dole–like initiatives in numerous African countries. The conclusion from Open AIR's work in three countries thus far is as follows (de Beer et al. 2014, 391):

> It remains to be seen whether such an orientation, fashioned more than three decades ago in the world's strongest economy, will be helpful in contemporary or future African contexts. The evidence provided in this book suggests that the IP commercialisation orientation for public research outputs will have a relatively benign impact in South Africa; potentially damaging consequences in the context of Ethiopia (with its moribund university–industry linkages); and highly uncertain results in Botswana (where the policy-making is very recent and awareness among public researchers very low).

The main reason such a dramatic policy shift away from open science may not have serious unintended consequences in South Africa is that relatively sophisticated stakeholders are crafting workarounds to avoid the worst outcomes (Ncube, Abrahams, and Akinsanmi 2013). Not all researchers are optimistic that problems can be avoided, however (Barratt 2010). Regardless, the South African approach sets a dangerous precedent for the rest of the continent, as well as the developing world more generally. Concerns have been expressed about the threats from the propertization of science in research focusing on other developing countries and regions, including India (Sampat 2009) and Latin America (Forero-Pineda 2006). Future open development-related research on open science cannot ignore this crucial issue.

"The case for open scientific knowledge clearly needs to be reconstructed," argues at least one leading innovation economist, to acknowledge that "the scientific commons is in danger, the costs of having it erode further are likely to be high, and that we ought to move to protect it" (Nelson 2004, 456 and 470). Much work remains to be done to understand when and where an open or proprietary approach makes more sense, and time is of the essence.

Interestingly for the conceptual framing of this chapter, ICTs factor very little in the leading research on open science. There are two possible inferences to draw from its absence. Either there is a major gap in the research, with open science scholars failing to recognize the central role of ICTs and give them due analytical attention, or ICTs may not be the definitive driver of open science. If the latter explanation is true (or even possible), open development researchers would do well to study the broader social and economic forces at play when building grounded theories about openness in science, technology, and innovation policies for development.

Another interesting contrast exists between research on open science and open innovation regarding the direction of the shift toward openness. In the realm of science, openness is being supplanted by appropriation through IP rights as part of the

push toward the commercialization of publicly funded research. As a result, science is under threat of becoming less open. In the realm of innovation more broadly, industry is becoming more open. Old models of closed innovation premised on isolation and secrecy are being replaced by more collaborative models based on the flow of knowledge across firm boundaries.

Is the trend similar with respect to other areas of open development, such as education and data? The following section of this chapter explores that question.

Summary and Next Steps

This chapter has highlighted theoretical gaps between the fields of open development and open innovation. It has suggested strategies to better integrate these two concepts, thus extending the potential of open development beyond its origins in ICT4D.

Significant discussion of the meaning of openness was contained in both major sections of the chapter. That discussion reveals that critics of openwashing may misunderstand the reason that companies call practices open, despite not meeting the criteria befitting one particular application of openness or another. The reason is that some practices may be labeled open according to the widely accepted meaning of *openness* in the management and innovation literature. This is not always a disingenuous or nefarious marketing ploy; it is an innovation strategy taught in introductory-level business school courses.

This chapter has also shown how the concepts of open innovation and access to knowledge provide crosscutting analysis of commonalities among applications including open science, open education, and open data. The practices that underpin open science are, in fact, modes of open innovation. Open education is itself an open innovation, and, whether they realize it or not, all (and maybe most) actors in the open education ecosystem are open innovators. Open data are among the key currencies exchanged via open innovation. Open innovation does not belong in a category with open science, open education, and open data; *it simultaneously subsumes, underpins, and permeates such things*. A new, theoretically integrated, and practically cross-cutting framework, as presented in figure 3.3, can facilitate more interdisciplinary and policy-relevant research.

As a final remark, there are two areas that stand out as priorities for future researchers who might use these insights to advance open development research. One relates to informality, the other to governance.

Regarding the informality of openness, it is critical to note the size and importance of the informal economy in many developing countries. The latest figures show that

the informal economy contributes nearly two-thirds of gross domestic product (GDP) in the region of sub-Saharan Africa, and, in some Southeast Asian countries, such as India, informal economic contributions constitute half of GDP. Groundwork has recently been done to prove that (1) extensive innovation happens in the informal economy (de Beer, Fu, and Wunsch-Vincent 2016); and (2) informal-sector innovators openly collaborate or appropriate differently from their counterparts in the formal sector (de Beer and Wunsch-Vincent 2016). An agenda to better measure and value these contributions has been proposed, but the hardest work of developing and implementing new metrics remains to be done.

Despite the importance of the informal economy in developing countries, little or no research has been published that explores open science, open education, or open data in this specific context. An opportunity exists for researchers to take up this challenge by situating those topics in a framework integrating open innovation and development. Without more explicit and systematic coverage of the informal sector, open development cannot fulfill its explanatory potential or have the impact that it otherwise might.

On the issue of governance, further research is needed to understand the best approaches to mediate tensions among openness, access, and the appropriation of knowledge. Knowledge flows throughout innovation systems and influences the degree to which the benefits of science, education, and data lead to positive development outcomes for all of society. Access to knowledge was identified as a central concept animating the last decade of work on ICT4D (de Beer and Bannerman 2013). Now the time is ripe to take an analogous step in the emerging field of open development. It is heartening to see Smith and Seward accept that challenge, as they did in chapter 2.

One conceptual tool to better understand how knowledge governance affects innovation across science, education, data, and other domains is the *commons*. Numerous scholars have been inspired by the work of Nobel laureate Elinor Ostrom on governing the commons (Ostrom 1990). Her insights have been adapted to create a framework for research on governing the knowledge commons (Hess and Ostrom 2006; Frischmann, Madison, and Strandburg 2014). Interesting scholarship using this framework has been published on commons-driven initiatives in genomics, medical research, astronomy, aviation, journalism, military technology, and much more. Chapter 2, picking up on this idea, identifies the potential of a knowledge governance framework in open development. But the knowledge commons framework for governing open innovation in developing countries has not yet been well developed, nor well studied.

Informal innovation and knowledge governance are just two specific priorities that might be possible to explore once the concepts of open innovation and open

development become better integrated. Moving open development out of the constraints of the ICT4D domain will help researchers address key questions around open science, open education, and open data. ICT4D researchers should be proud of the open development theory that they have spawned. The next step is to let it loose.

Notes

1. See the home page of Creative Commons (https://creativecommons.org/choose/).
2. See MIT Open Courseware (http://ocw.mit.edu/donate/why-donate/#how-much).

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Lessons from IDRC Research

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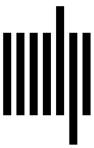

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