Innovation for Sustainable Development

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Disentangling the debate on open access for meeting global challenges in life science

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The open systems movement proposes legal and organizational arrangements to encourage resource exchange and increase the potential for research collaboration and innovation. It is attracting increasing attention from actors seeking collaborative solutions to complex global challenges that cut across issues, agencies and scales. The G8 effort to establish an open data initiative for food security provides a good example. As part of their joint commitment to addressing food security, the members agreed to 'share relevant agricultural data available from G8 countries with African partners and convene an international conference on Open Data for Agriculture, to develop options for the establishment of a global platform to make reliable agricultural and related information available to African farmers, researchers and policymakers, taking into account existing agricultural data systems.' Other initiatives such as *Science Commons*, the *Cambia Initiative*, *Creative Commons*, *Linux*, *InnoCentive*, *Collaborative Drug Discovery*, the *GeneWiki Initiative*, *Open Source Drug Discovery* and the *Open Source Seed Initiative* have been pushed by various associations, governments and governance systems.

Taken together these open initiatives are often considered in the business press, and by academic scholars, lawyers and policymakers to be at odds with proprietary regimes based on strong intellectual property rights (IPR).[1] As it relies on the principle of cooperation to remove potential barriers to resource access, the open

1. A strong IPR system enables recognition of exclusive rights over creations. Such a system typically includes established legislation, a patent review structure and a court based enforcement mechanism.

system approach is perceived to offer an alternative to competition-based strong IPR. This paper argues that the two systems do not necessarily conflict and are increasingly integrated in practice. It explores the continuum from purely open to purely exclusive. Additionally, the paper demonstrates that neither the open nor the strong IPR system considers the redistribution of returns for the use of resources in ways that address global inequities and that would demonstrate commitment to solving global problems such as food insecurity. To integrate the consideration of equity, even an open system would need to develop institutions that redistribute the benefits derived from use to a wide range of actors.

The paper is structured as follows: the first part provides clarification of the multiple conceptions of open systems. The second part discusses the relationships between open systems and IPR and argues that any attempt to balance public and private interests in a dichotomous way elides a reality that is much better captured through a hybrid model that integrates open and proprietary systems. In this second section, we identify various parameters that could be used to describe a hybrid model. The third part develops these ideas through the specific example of the access, exchange and use of genetic resources for food and agriculture. The conclusion points to how proprietary and open systems might affect the redistribution of benefits from research that is increasingly of focus in the global context.

The multiple conceptualizations of open systems

The concept of open systems captures a wide range of different concepts that creates considerable opacity around the meaning of the term *open* and confusion about how it is actually operationalized in actual initiatives. The differences among the terms *open innovation*, *open data*, *open science*, *open access (OA)* and *open source* are not immediately clear. Nor is it obvious how the concept of open system relates to the concepts of public domain or commons. Here we explain the origin of the concept and the contexts within which it operates instead of attempting to provide a single definition that encompasses all of the possible semantic variations.

Historically, open systems are associated with the practice of science, an activity and profession recognized to value norms of sharing and reciprocal exchange. As the practice of science has increasingly integrated private sector partners and proprietary resources, norms of openness have been challenged, raising concerns about a consequential reduction in the production and dissemination of knowledge. There have been two general types of responses, one politically motivated and one economically motivated. The political response seeks to democratize access to knowledge by resisting the extension of monopoly and control over information. The economic response seeks to develop an alternative model in which open exchange of resources enhances production and innovation by taking advantage in particular, of rapid progress in digital information and communication technologies. We first describe briefly the open science system before turning to the descriptions of two responses, which we name the *political model* and the *economic model*, respectively (Figure 1).

OPEN SCIENCE: A MODEL CHALLENGED BY THE ACTUAL INTERACTIONS BETWEEN ACADEMIA, INDUSTRY AND GOVERNMENT

Open science refers to the longstanding tradition of openness that is embodied in the social conventions and practices of academic science. They are usually thought to comprise Mertonian norms of communalism (common ownership of scientific discoveries), universalism (claims of veracity that are independent from the specific attributes of the one presenting them), disinterestedness (new knowledge sought without any personal interest but purely for its own sake) and organized scepticism (importance of peer-review process) (Merton, 1973). By facilitating disclosure and diffusion of knowledge, these norms establish an incentive-based system that is conducive to *cumulative knowledge production*. Open science relies on a system of public (or coordinated) expenditures to reward those who contribute to this cumulative knowledge production over the long term (Mukherjee and Stern, 2009).

This model has progressively been challenged by an evolution in the practice of science, particularly academic science. In general, these changes have resulted in greater emphasis on more applied and societally relevant research, and more interactive relationships between academia, industry and government. For example, research has shown that universities are increasingly involved in technology transfer and commercialization (McKelvey and Holmén, 2009) and active in a wide array of formal and informal collaborative relationships (Link et al., 2007; Grimpe and Fier, in press; Van Looy et al., 2004; Hall et al., 2001). These changes have been described by scholars through concepts such as *Mode 2* science (Gibbons et al., 1994); innovation systems (Edquist, 1997); academic capitalism (Slaughter and Leslie, 1997); post-academic science (Ziman, 2000); and triple helix (Etzkowitz and Leydesdorff, 2000).

Given the open science logic and its recent evolution, we observe two types of responses: the development of a political model through the open access and open data, and the development of an alternative economic model intended to take advantage of the new knowledge economy, through the open source and open innovation mechanisms.

THE POLITICAL MODEL: OPEN ACCESS AND OPEN DATA

The open access movement promotes public sector values in a context of the increasingly proprietary environment for material and non-material resources of scientific significance. Open access advocates, mainly found in the academic sector, promote the removal of access barriers to academic research. This movement has gained importance with the rise of the Internet which dramatically decreased distribution costs. The open access movement originally sought to address problems of access to publications through circumventing obstacles to the sharing of information and promoting increased access to knowledge for subsequent research.

Three major international initiatives on open access were launched by universities, libraries, journal editors, publishers, foundations, learned societies, professional associations and individual scholars in the 2000s: the Budapest Open Access

Initiative[2] in February 2002; the Bethesda Statement on Open Access Publishing[3] in June 2003 and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities[4] in October 2003. While these initiatives strongly influenced the open access movement, their focus on publication outputs has overshadowed the issue of access to research inputs such as data, which are an essential ingredient of research and the objects of significant annual public investments (Arzberger et al., 2004).

The recent push towards open data represents an extension of this open access movement to include data for research purposes. It aims to embrace the opportunity offered by information and communication technologies to make data produced by scientific research more freely available and usable outside the context of production. Data production and sharing is conceptualized as a driver for research rather than simply a component of research processes (Leonelli, 2013). As their main promoters put it, 'The 21st century is currently witnessing the establishment of data-driven science as a complementary approach to the traditional hypothesis-driven method. This (r)evolution accompanying the paradigm shift from reductionism to complex systems sciences has already largely transformed the natural sciences and is about to bring the same changes to the techno-socio-economic sciences, viewed broadly.'[5] The recent push by the G8 is also justified on the basis of a recognized growing need to systematically consider data access and sharing issues beyond national jurisdictions for the purpose of addressing global concerns.

Finally, the open data movement has expanded to other categories of publicly-funded data and information, in particular government data, including data that has been produced or commissioned by government or by government-controlled entities and data which can be freely used, reused and redistributed by anyone).[6] Although access to government or research data appears similar, the underlying tensions that constrain openness may differ. For example, restrictions on open government data may be due to privacy and confidentiality concerns but legal protection related to ownership rights may limit openness of research data.

To summarize, the political model of open access has been applied to several objects including publications, research data and government data. This approach is political in the sense that it defines general principles but rarely prescribes how open access should be concretely implemented or managed. In this sense, the political model of openness designates consideration of access (with no price or permission barriers) rather than consideration of use as would be found in an economic model. Practically speaking, open access can be organized through various institutional means. By contrast, open source mechanisms, as described in the next section,

2. http://www.budapestopenaccessinitiative.org/
3. http://legacy.earlham.edu/~peters/fos/bethesda.htm
4. http://openaccess.mpg.de/286432/Berlin-Declaration
5. http://www.epjdatascience.com/
6. See http://opengovernmentdata.org/

carry a more normative connotation for the entities in the sense that engagement and use must comply with legal and organizational rules meant to control behaviour and outcomes.

THE ECONOMIC MODEL: OPEN SOURCE AND OPEN INNOVATION

Open source is the main mechanism by which the open systems approach is actually operationalized in various sectors. It proposes a model of production and innovation where barriers to the circulation of data, knowledge and material are lower due to safeguards that buffer the legal protections in a strict intellectual property rights (IPR) regime. Open source models originated in the software developer community to foster community-wide collaboration in a context of increased barriers created by copyrights. This system however was built upon open access practices that were established in the early days of software programming, when free distribution of source code was used as a strategy to encourage people to buy hardware (Weber, 2000). With the rise of personal computers, software turned into an extremely valuable and lucrative product and access to and use of it became protected by IPRs.

These and other constraints led the community to revive the open access logic for source code. Two important initiatives established the foundation for the open source system: 1) the creation in 1984 of the Free Software Foundation by MIT researcher Richard Stallman and 2) the birth in 1990 of the free access Linux operating system by Linus Torvalds, a computer science student at the University of Helsinki. By contrasting the emerging proprietary (IPR)-based model, these two initiatives emphasized the process of software development rather than the software product (Weber, 2000). They insisted on the need to rely on the distributed, albeit coordinated, capacities of multiple participants to reach the modularity and complexity required for ongoing innovation.

Concretely speaking, an open source model makes source code available to any user as long as the user promises not to appropriate it privately. The underlying rationale is to apply an IPR-based licensing strategy to establish a protected commons of accessible resources desired by the programmer (Samuelson, 2001). An open source licensee agrees to follow the same use rules that applied during acquisition when he or she transfers the source code to another user. In contrast to an open access approach, open source rules may restrict commercial use, including the creation of derivative work.

The same concept has been used by the Creative Commons Initiative to provide creators with several licence options to promote openness and widespread use while protecting against misappropriation (i.e. proprietary claims on public information). Various conditions imposed on Creative Commons licences include: i) *Attribution*, which gives the user the right to distribute, remix, alter and build upon the work, even commercially, as long as proper credit is paid to the right holder; ii) *Attribution-ShareAlike*, which is similar to the open source software licences in that it gives the user the right to remix, alter and build upon the work even for commercial purposes, subject to proper attribution, and licence their new creations under identical terms;

iii) *Attribution-NoDerivs*, which allows the right to redistribute the original work (with proper attribution), to commercial and non-commercial entities but does not allow derivative works based on the original; iv) *Attribution-NonCommercial*, which permits non-commercial use and derivative works do not have to be licenced; v) *Attribution-NonCommercial-ShareAlike*, which is a combination of cases ii and iv; and vi) *Attribution-NonCommercial-NoDerivs*, which is a combination of cases iii and iv.[7]

The extent to which open source models can be applied to other sectors, in particular agriculture or health, which may be encumbered by monopoly rights other than copyright is subject to debate. For agriculture and health, patent-based intellectual property (IP) mechanisms may not enable the same open source solutions as copyright-based IP mechanisms. Additionally, the requisite investments for research and innovation in the software sector may differ substantially from those needed in the agricultural or pharmaceutical sectors. Hence cross-sector application of the open source model is likely to be context dependent.

In summary, this innovative legal arrangement has been designed to take advantage of the collaborative capacities of highly distributed networks of developers, testers and users motivated by strong personal stakes in ideas, processes and innovations (Rhoten and Powell, 2007). We find this same logic applies to the notion of open innovation, described in the next section, even though the open innovation approach does not incorporate a legal dimension and is not linked to an IP regime.

Open innovation models have been developed in the business sector to describe a new way for companies to tap into resources (mainly non-material ones such as knowledge) that are found outside of their control. As noted in an OECD policy brief (2008), 'companies look at open innovation as a close collaboration with external partners – customers, consumers, researchers or other people that may have an input to the future of their company. The main motives for joining forces between companies is to seize new business opportunities, to share risks, to pool complementary resources and to realize synergies.' Prior work notes that firms that are not collaborative and do not exchange knowledge face long-term competitive disadvantage (Koshatzky, 2001).

The open innovation model shifts focus further away from technology-push research efforts (Herstad et al., 2010) and emphasizes the importance of co-operation and collaboration efforts to increase research and development options. It recognizes that the source of knowledge is often external clients, suppliers, competitors and research institutes, while the locus of innovation can still be the firm (Enkel et al., 2009). Open innovation considers the movement of otherwise proprietary products and processes to others through licensing arrangements that enable faster innovation. It also encourages co-creation through partnerships (Vanhaverbeke et al., 2008). The trend towards greater open exchange of knowledge has been fostered by globalization which broadens 'the choice of potential partners giving rise to the development of global innovation networks' (OECD, 2008).

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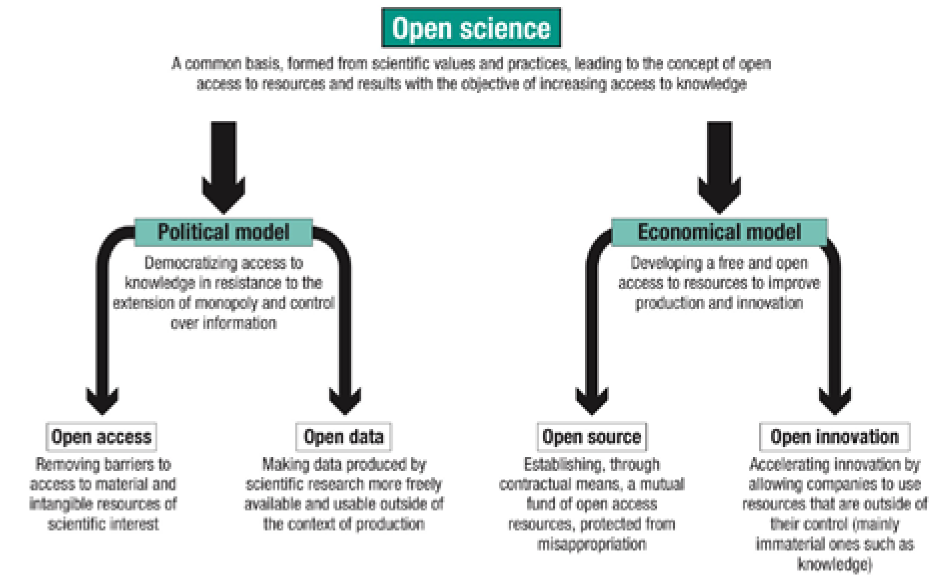
7. See http://creativecommons.org/licenses/?lang=en

FIGURE 1 **Open science: collaborative models of access to knowledge**



Source: Authors

Importantly open innovation is not equivalent to open access to knowledge or technology. Rather, it 'may still imply the (significant) payment of licence fees between companies for intellectual property' (OECD, 2008). Nevertheless, open innovation will require different IP considerations to those of closed IP systems (Chesbrough, 2006; Fauchart and von Hippel, 2008).

OPEN SYSTEMS, PUBLIC DOMAINS AND COMMONS

This second part aims to clarify the context in which the several open systems concepts have been devised and the extent to which they have influenced a range of concrete initiatives. However, discussing in detail the relationships between the various conceptualizations of open systems and the notions of public domain and commons is outside the scope of this paper. Nevertheless, it is important to note that in the same way as there are multiple open systems, there are several conceptions of the public domain and the commons.[8] What matters for this paper is the following general observation: concepts of open science, open access or open data are close to the notion of public domain in the sense that they promote access without any

8. See, in particular, Pamela Samuelson (2006) for a detailed presentation of 13 different conceptions of public domains.

restriction to resources. The concepts of open source and, to a lesser extent, open innovation are close to the concept of commons: they carry some 'private-collective' features (von Hippel E., von Krogh G., 2003) where rules of access and sharing are agreed within a specific group of players and some restrictions may apply. The cost of entry into this group may not necessarily be high but it involves agreeing to these rules.

Relationship between the various conceptions of open systems and IPR

As previously noted, the line between public and private sector research is becoming increasingly blurred as the three primary sectors – academia, government and industry – are increasingly collaborating, sharing knowledge and co-developing new innovations. New entrepreneurship norms and social practices have appeared in the academic sector[9] and all three sectors have sought to build collaborative relationships. Within this evolving institutional context, new open systems are being adopted and integrated as means of addressing either the tenets of the political model or the recognized advantages of the economic model. Given the complex institutional environment, it is reasonable that open source relies on IP rights and licensing terms to establish open systems, while open access endeavours maintain a flexible approach to the systemic inclusion of IPR. We show in this section that a clear separation of open and proprietary interests elides a reality that is much better captured through hybrid models of interconnected open and proprietary visions.

THE FALSE DICHOTOMY BETWEEN OPEN AND PROPRIETARY VISIONS

It is common to consider (material and nonmaterial) resources to be either in open access or privately held. In reality, governance of these resources is better described as a continuum where purely open access and purely private control are two end points. At the open access end we may find government-funded agricultural genebanks that provide seeds or other genetic resources upon request, free of charge, and with no restrictions on use. At the other extreme, knowledge about the function of a genetic marker for a type of livestock breed is privately held. In between, some open access resources may carry some restrictions – shown as differentiated open access rules in the previous section – and some kinds of IPR protection may offer greater access to valuable information than would otherwise occur. Moreover, firms may promote open access to resources as a strategic means of decreasing access and input costs. This could occur when health or cosmetic companies decide to discourage proprietary claims over traditional knowledge or genetic resources that were previously recognized to be freely available in the public domain.

Open source models have also an intricate relationship with IPR. Open source

9. Rodriguez provides evidence showing examples of these changes in terms of 'entrepreneurial universities, academic spinoffs, consultancy functions of professors, recruitment of PhD candidates or post-docs to develop research lines already set up by sponsors, intellectual property rights, licensing, project proposals and grants, directed programmes, university–industry collaborations, global networks, interdisciplinary centres and teams, research performance evaluations and so on'.

models promote public domain values through the use of sophisticated institutional and legal arrangements borrowed from IPR and contractual law. As pointed out by Samuelson (2006), '…open source licences allow a far broader range of uses than most proprietary software licences, yet they are, as compared with wholly free IP-information resources, much more restrictive.' Although open source models are aimed at serving public accessibility, the IPRs and licence terms on which they are built still incorporate significant restrictions and demands on users. This situation could become cumbersome when multiple open source models operate simultaneously, such as when scientific research requires integration of various datasets containing data that do not share the same restrictions. This is of particular concern for large, interdisciplinary, global scale projects. In effect, complying simultaneously with various open source legal conditions may create barriers that lead to less openness rather than more; the opposite of what was intended.

By contrast, the pure public access approach allows the combination and integration of different resources without concern for legal status. Several open source initiatives have tried to respond to the problem of data integration by integrating public domain concepts. Examples include the Public Domain Dedication and License (PDDL), the Science Commons Data Protocol and the Creative Commons Zero (CC0) licence. As one conceiver of the CC0 licence puts it (Nguyen, 2008), 'the solution (…) is to return data to the public domain by relinquishing all rights, of whatever origin or scope, that would otherwise restrict the ability to do research (i.e., the ability to extract, re-use, and distribute data). The goals of the Protocol are to keep data open, accessible, and interoperable, and its virtues lie in its simplicity, predictability, and consistent treatment of users and data.'

This public domain solution, where no rights are reserved for the data providers, may solve problems of data integration but it also generates new ones in relation to potential disincentives to contribute to the public domain due to lack of proper attribution and fear of data integrity loss. Ironically, the situation ends up where, as noted by Rhoten and Powell (2007) '*just as IP law can be viewed as an impoverishment of the public domain, openness and access can dampen incentives that allow innovations to be created and incorporated into the public domain*'.

In summary, conceptualizing open systems as the opposite of proprietary regimes is misleading. Rather, there exist combinations and composites that establish rules for access, exchange and sharing of resources for research and innovation. More than a continuum within a single dimension, it might be more appropriate, as described in the next section, to refer to a spectrum that unfolds in several dimensions.

BEYOND 'OPEN SYSTEMS VERSUS PROPRIETARY REGIME'

The debate between open and proprietary visions focuses almost exclusively on the accessibility dimension in relation to the legal status of resources. However, exchange of resources takes place in a broader collaborative context that involves other equally important dimensions such as:

- The *incentive structure* which determines who establishes the open system, what the system goals are, who contributes to it, what the motivations are to contribute to it, and who pays for its maintenance over time.

- *Resource characteristics* including the type of resource exchanged: data, information, knowledge, material.
- *Structural constraints and opportunities* such as the availability of contingent information about the resource, distribution or concentration of the resource, and feasibility and channels of access.
- *Organization and institutional considerations* such as whether the decision and control structure is hierarchical or distributed and the amount of discretion and control entities have for distribution, monitoring and tracking of exchange and use.
- *Redistribution considerations* that address the benefits from the use of resources including: the types of benefits, how benefits accrue, who governs allocation or reallocation of benefits, and commitment to redistribution to address broader goals such as social equity, economic capacity, food security and environmental conservation, among others.

These dimensions recognize a complex context of exchange in which tensions arise between equity and efficiency goals, exchange based on explicit rules versus exchange based on reciprocity and trust, relationships, and reliance on market mechanisms versus regulatory mechanisms to induce contributions, to name a few. The ways these tensions are addressed define various points that are part of hybrid models for resource exchange in research and innovation.

Towards hybrid models of research and innovation – the case of genetic resource access and use

Looking ahead to the near future, it is possible to consider the various models presented in this paper as the basis for more complex hybrid models that integrate institutional actors, norms of access and openness, proprietary constraints on resource inputs to research, innovation strategy and technological change, equity and redistribution of benefits, and collaborative organizational solutions to global problems. Yet almost any hybrid model demonstrates several inherent tensions. First, the norms of open science are steadily interacting with proprietary institutions as universities, companies and governments seek to encourage greater societal benefits from research. Second, open systems approaches are recognized to be both of strategic advantage and political import, yet there is an evolving modulation of openness and proprietary rights to simultaneously balance the value available to multiple stakeholders. Third, new international policies seek to both stimulate effective use of resources to solve complex problems and protect the private and intellectual property rights of multiple stakeholders. Yet, governments and stakeholders disagree on how to value the trade-offs. These inherent tensions are resulting in the creation of hybrid systems of research and innovation that seek to satisfy multiple objectives. While it is too early to assess the effectiveness of hybrid systems, the implementation and operationalization of one example – the access and benefit sharing policy established in the Nagoya Protocol to the Convention on Biodiversity – provides a good case in point.

ACCESS AND BENEFIT-SHARING IN THE NAGOYA PROTOCOL TO THE CONVENTION ON BIODIVERSITY

The Access and Benefit-Sharing regime for genetic resources was set up under the Convention on Biodiversity and further negotiated under the Nagoya Protocol in 2010. When it comes into force, it will require nations to set up procedures for access and rules for the fair return on the use of genetic resources that comply with the protocol. Member nations will be required to enforce the provisions of the Nagoya Protocol in their own nations. At its core, the new context shifts control of genetic resources away from researchers in all sectors and into the hands of new government institutions. Depending on the formulation of the new *organizational structures* developed at the national and sub-national levels, receivers and providers of genetic resources will realize new constraints on and opportunities for access to genetic resources, which will necessarily effect distribution of the material and the ability to collaborate on research. The value and availability of the resources will also be affected by *contingent structures* such as the data, information, natural environment, concentration and other factors related to the genetic resource.

The incentive structure represents a combination of open access and property rights. Signatory countries agree to facilitate access to genetic resources by individuals in other countries for research and other non-commercial purposes. Access is not truly open as receivers of genetic resources are required to seek access through a transparent, government approved process. Should the intended use of the genetic resource include commercialization, an agreement is required to share the benefits of commercial success with the provider country. Hence, the policy seeks to simultaneously encourage access and preserve property rights. The resource characteristics covered by the access provisions relate only to genetic resources, while the redistributional considerations concern the benefit sharing provisions. As benefits could be either monetary or non-monetary (data, information, training, etc.), it is possible for countries to receive educational resources that contribute to capacity development as a result of a successful innovation based on a nationally-held genetic resource.

Given this new policy context, it is likely that multiple hybrid systems will develop to respond to and seek to strike a balance between the different tensions described above. The following two options provide alternatives that serve as heuristics for the characteristics of two future hybrid systems.

HYBRID SYSTEM 1: A CONSTRAINED OPEN SYSTEMS APPROACH

This trajectory represents a continuation of the integration of the three types of institutions – university, government and industry – in which genetic resources are obtained and used on a research project or programme basis. Access is facilitated for specific purposes and use is dependent upon explicit formal agreements on benefit sharing. This hybrid is likely to produce a greater concentration of resources, a greater application of property rights that control material and data flows, potentially greater regulatory burdens and likely increases in transaction costs related to materials and data. This hybrid leads to a perspective of an increasing closure of the knowledge production and innovation system in which private property rights increasingly dominate and commercialization goals increasingly permeate the university-government-industry alliance. This closure eventually constrains exchange and collaboration among groups or clubs of researchers that depend upon membership restrictions and joint capacities to access valuable resources. Flows of data and materials are strong within clubs but not necessarily between clubs where information flow is more controlled and based on strategic advantage. This hybrid favours a competitive approach in which groups or clubs compete for solutions to global problems that have both proprietary and public goods outcomes, but where distribution and redistribution of benefits from the use of materials are highly formalized. For such a model to address equity, specific arrangements need to be made to ensure improved access to the gains arising from shared resources and commitment towards activities that maximize global welfare. In sum this approach favours a relatively strong application of property rights and a more constrained open systems approach.

HYBRID SYSTEM 2: A STRONGER OPEN SYSTEMS APPROACH

This hybrid calls for a greater distribution of resources and capacity. It responds to the structural constraints that limit the ability of the first hybrid model to address major problems at a global scale. It recognizes that the combination of distributed technology and skills across all countries and the inherent stickiness of information and materials bring about a distribution, rather than a concentration, of research and innovation capacity and control of research inputs. It assumes an increasing awareness by scientists about their responsibilities towards global problems, equity considerations and balance of needs across countries. In addition, scientists increasingly receive credit for a broader array of benefits (monetary and non-monetary) for access to and use of materials.

This hybrid takes advantage of the information and communication revolution that enables greater exchange of information, greater distributed capacity development, and reduced need for exchange of materials. This hybrid assumes that there will be numerous repositories of valuable biological materials and data, an increased desire to control materials locally, and a stronger local strategic approach to carefully manage the exchange of materials for non-monetary returns that benefit local capacity. Scientists will depend upon distributed sources of materials and information. Clubs or groups of scientists for multiple sectors will exist, but the barriers to entry are low and movement of human resources across them is easy. Additionally, global problems are varied enough – across fields of health, agriculture, environment – and local capacities broad enough, that membership of clubs is more fluid. This hybrid favours a stronger approach to ensuring an open system and creates greater interdependencies and greater recognition across all actors, such that exchange, research and innovation all take place on equitable terms. Scientists in all sectors are recognized for educating, training and providing other non-monetary benefits when accessing and using genetic resources. In this hybrid, property rights on genetic resources are still recognized, but they are activated further downstream, when commercial intent is clear and products or processes are more developed. As a result, property rights on genetic resources do not dictate collaboration structures or drive research processes. In terms of redistribution, emphasis is put on reinforcing the institutions in charge of ensuring effective use of shared resources by stakeholder groups and countries that are less endowed, and on valuing more reciprocal behaviours in order to strengthen the long-term cooperative capacities of stakeholders.

Conclusion

Open systems describe a variety of collaborative approaches that focus on improving access to resources that are becoming increasingly protected by proprietary claims. These approaches recognize the collective nature of research and innovation processes and open them up to new actors that are not usually included in research collaboration models. However, the over-emphasis in OA discussions on the accessibility dimension runs the risk of developing what Chander and Sunder (2004) refer to as the romantic vision of the public domain: 'the notion that when a resource is open to all by the force of law, all will be equally able to exploit it.' Certainly, open systems do not empower all actors in the same way. In fact, effective use of open systems requires pre-existing infrastructures, knowledge and skills that are most likely to be found among the wealthier or higher capacity entities (e.g. research organizations, countries or stakeholders). Consequently, establishment of an open system of exchange does not solve the equity issues most often associated with IPRs.

Inattention to the redistributional dimension could result in significant drawbacks that could potentially alter the ways in which various stakeholders engage in research and innovation processes and result in limitations on the sharing of resources. Redistribution goals and structures are critical factors affecting research that require collaboration among multiple actors that have different objectives and capacities.

This chapter has presented two stylized hybrid models that offer viable future trajectories for research and innovation. They borrow elements to both open and proprietary systems and combine them differently to propose an institutional framework in which several actors could collaborate to contribute to global challenges. Both models integrate accessibility and redistribution issues within a broader cooperative framework. However, the way each addresses the redistribution dimension differs fundamentally. The second hybrid model adopts a human capabilities approach by improving research and innovation capacities of the widest range of actors. By promoting a club approach, the first hybrid model is less concerned with increasing participation to research and innovation processes. It rather focuses on privileging efficiency for the delivery of socially productive outcomes (i.e. global goods and services that are of interest to all).

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