

Contractually constructed research commons: a critical economic appraisal

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1 Introduction

The paper attempts a survey of the main economic issues concerning the emergence of contractually constructed research commons, with a particular attention to the field of biological/genetic resources and biotechnologies.

In the last decade there has been a growing and high pitched debate about the expansion of exclusionary and proprietary strategies (intellectual property rights and sui generis regimes, restrictive licensing etc.) for the appropriation of the value of knowledge and information resources. The main point of contention has centered on the justification for the adoption of these strategies and how actors in this setting achieve to manage the production, dissemination and use of knowledge and information (Dreyfuss, Zimmerman & First, 2001). On one hand, the optimists have highlighted the powerful synergies in the coupling of strong rights and contractual freedom, identifying in markets, patent pools and collaborative agreements the mechanisms to efficiently allocate resources to the most productive users. On the other hand, the pessimists contend that the expansion of property rights and exclusionary strategies is likely to delay or deter innovation because of an overall increase in transaction costs and the emergence of strategic behavior in the integration of complementary information resources. Further, they see collaborative private arrangements as a whammy that stifles competition and imposes negative externalities on both consumers and prospective innovators (Hope, 2008).

With this perspective, the recent developments and initiatives for the implementation of contractually constructed research commons ask for a re-assessment of this debate. These new organizational initiatives seem to provide a balance

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between the two diverging positions. Crucially, they recognize the benefits from ownership and exclusivity that can accrue to innovators. Nevertheless, these experiences use property rights to go beyond the familiar control of assets that occurs either within organizations, in markets for technologies or among parties of close-knit collaborative agreements. In turn, these experiences elicit a broader cooperative solution in the form of standard contractual regimes that should be adopted and shared by the members of research communities. The final goal is indeed to avoid unnecessary restrictions, to pool resources and to give researchers access to the large aggregate that could result from the contributions of all those who adopt such contractual arrangements.

The main research question underlying the paper is basically the same posed by scholars in the past years when realizing the growing trend in the privatization of scientific and research activities: given the expansion of proprietary and exclusion strategies it is necessary to evaluate whether institutions for the transfer of knowledge and information resources are emerging or failing (David, 2004; Heller & Eisenberg, 1998; Eisenberg, 2001). Answering to this question is of paramount importance for assessing the viability and sustainability of the research commons initiatives as an alternative institutional framework for coordinating transactions.

If exchanges and transactions are fading, then to what extent the commons based forms of knowledge production are effective and long-standing solutions to this problem? By contrast, it may be the case that the alleged deadlock in transacting and integrating resources is just a transitional condition, as more actors in the research communities will learn to interact through market mechanisms or will develop networks of collaborative agreements. Arguably, these options put research commons initiatives in a more evolutionary perspective and suggests that different institutional settings may compete and coexist depending on the technological and economic changes as well as on the evolution of agents beliefs. Further, this option implies that the sustainability of research commons may be affected by agents adaptive behaviors, collective action and path-dependent dynamics.

In summary, the paper presents the main economic issues that represent fields of contention among legal and economic scholars when analyzing the impact of the expansion of property rights on the access and production of knowledge and information resources. Crucially, the same issues represent the most challenging research paths to deepen our understanding about the prospective viability and success of research commons.

The paper is organized as follows: section 2 describes the emergence and rationale of contractually constructed research commons; section 3 presents the most relevant economic arguments concerning the emergence and sustainability of these

organizational forms; linking all the pieces of the previous section, section 4 concludes by proposing an evolutionary perspective that should inspire the design of emerging research commons.

2 Emergence and rationale of contractually constructed research commons

Contractually constructed research commons represent emerging institutional forms for the management of knowledge and scientific material. Against the alleged privatization pressures that have adversely affected research and innovation activities, these initiatives aim to introduce standard contractual forms, which contemplate non-exclusive use and access to information resources and research inputs that are covered by some forms of exclusive rights.

Contractually constructed research commons have come out in the last decade in many different fields of scientific production and innovation. For instance, Reichman & Uhler (2003) have been engaged in proposing a contractually reconstructed commons for scientific data, as a response to enhanced copyright protection and new sui-generis protection for databases. As for genetic resources for food and agriculture, states have signed in 2001 the FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), which devises a multilateral system of facilitated exchange for germplasm. Within this framework, the contracting parties mutually recognize sovereignty rights over their respective genetic resources, as established by the Convention on Biological Diversity (CBD), but use those sovereignty rights to pool the crop genetic resources held in their national collections for agricultural innovation and crop development (Helfer, 2005). A similar movement is also occurring in the microbial research community, where an integrated research commons has been proposed in order to guarantee access to microbial materials, data and knowledge, in the form of scientific publications (Dedeurwaerdere & Dawyndt, 2005). Finally, another initiative that is worth mentioning in biotechnology is that undertaken by CAMBIA, a non profit research institute that has since pioneered the use of open-source-like licensing of research tools and enabling technologies (Hope, 2008).

All these experiences, although different in their nature and scope, unveil a common narrative account that is useful to summarize for understanding the emergence and rationale behind contractually constructed research commons. Almost all the proposals and initiatives start recognizing the great economic and technological changes that have significantly changed the scientific research landscape.

These changes have improved the ways to produce and distribute knowledge and information resources, but at same time have drawn the agents' expectations in capturing and controlling the value of their research assets. The recent evolution of digital technology and knowledge base has indeed created greater opportunities for the integration of different types of knowledge in networked environments and complementarity between increased computational power and greater scientific understanding. However, the boundaries between basic and applied research have increasingly blurred, especially in those fields of science that refer to the "Pasteur's Quadrant" (Stokes, 1996). Being characterized by the achievement of practical objectives, research outputs in these sectors are the most susceptible of commercial exploitation and economic return. Further, as technical routines that represent valuable know-how have been more and more incorporated on or near the face of research tools and materials, subsequent innovators could duplicate without need of incurring the time and costs of reverse-engineering (Reichman, 2000).

As a result, although the greater opportunities for the exchange and integration of knowledge, there has been a growing trend in building up barriers to the access and use of information resources with the objective to appropriate the value of research outputs. The expansion of intellectual property rights, the creation of sui-generis regimes and adoption of restrictive licensing strategies are common institutional responses that have proliferated in almost all the fields of knowledge production (Heller & Eisenberg, 1998). In addition, because of the highly diversified environment of R&D, characterized by great heterogeneity of players in the public and private sector, the enclosure movement has followed a "domino effect". The privatization pressures that has been initially supported by some players internally to the system has created a shifting balance in favor of proprietary interests. This has eventually led to defensive reactions by other players, who conform to the changes in the legal framework by adopting exclusionary strategies against the erosion of open access models.

While the adoption of exclusionary and proprietary strategies is usually justified with the objective to appropriate the value of research and to enhance a market-based allocation of research inputs (Merges, 1995; Arora, Fosfuri & Gambardella, 2004; Smith, 2007), this move has been perceived to generate unintended consequences and to engender negative effects to the flow of resources in R&D activities. Many commentators have highlighted the risk that the new institutional settings may stifle scientific production and innovation because of the increase in transaction costs, the erosion of norm of science in the dissemination of knowledge or the emergence of strategic behavior in the integration of complementary information resources. These concerns have found a powerful metaphor in the tragedy

of anticommons (Heller, 1998; Heller & Eisenberg, 1998). Further, the new scenario tends to have a dual equilibrium (Reichman & Uhler, 2003). On one hand, there exists a formal system of exchange of information resources where, albeit the increasing restrictive conditions, the highest value transactions take place. On the other hand, there is growing evidence of an informal system where lower value and routine transactions take place without entering into any formal legal undertakings. This system, based on the ties of a close knit research community, is less restrictive but nevertheless creates club goods closed to not trusted parties and generates potential negative externalities on the quality control of the resources exchanged in cumulative research (Furman & Stern, 2006).

With this perspective, it is because of the concerns for unintended consequences and drawbacks that contractually reconstructed research commons have been proposed. Crucially, the rationale behind such new approaches is twofold. First, coping with the new proprietary framework, research commons envisage new institutional arrangements such as compensatory liability regimes or standardized agreements that contractually regulate the right holders relations between all the participating research communities and their members. Second, research commons aim to reconstruct a pre-competitive environment, which has been eroded by the defensive attitude and strategic behavior adopted by different players in the research community.

3 Economic arguments for and against emerging research commons

Although the narrative account used to justify contractually based research commons seems to provide meaningful arguments, the attitude for their adoption is hardly shared in the policy and academic debate. For this reason, understanding whether contractually based research commons are viable solutions for the management of knowledge production is an empirical and theoretical question of considerable complexity. In this context, it is possible to identify three main economic issues that should be analyzed in order to understand the strengths and weaknesses of proposed research commons.

3.1 Transaction costs and the quest for the anticommons tragedy

The issue of increasing transaction costs and the reality or absence of an anticommons tragedy may be deemed as the primary economic field of contention among detractors and supporters for contractually constructed research commons. An anticommons tragedy is caused when multiple owners each have right to exclude others from a scarce resource, leading to under-utilization due to the lack of coordination among the various rights holders (Heller, 1998). The metaphor of the anticommons tragedy has been promptly ported in the intellectual property debate by Heller & Eisenberg (1998). In their much-cited paper, the authors use the anticommons image to highlight the concern for the emerging proliferation of concurrent fragments of intellectual property rights or the restricted access to upstream discoveries due to stacking licenses strategies. Likewise, David (2008) identifies three analytically distinct layers of the anticommons tragedy, namely, search costs, negotiation costs and multiple-marginalization costs. While the first two types of costs are clearly incurred before any deal can be concluded, costs derived from multiple marginalization result in inefficiency by raising the price of complementary research assets.

Increased transaction costs are therefore one of the key ingredients for explaining the troubles arising from the proliferation and strengthening of exclusive rights, but this is not enough by itself to bring about an anticommons tragedy. Even in the presence of proliferating exclusive rights, the anticommons tragedy may be avoided, provided transaction costs can be kept low by intermediaries, infrastructures and institutional mechanisms other than the proposed research commons (Hope, 2008). In addition, even royalty stacking by multiple owners highlighted in the multiple-marginalization problem may be less severe than expected.

As a result, evidence of an anticommons tragedy in all its forms may be a hint in favor of the proposal of a contractually based research commons. Unfortunately, the few empirical evidence addressing this subject does not bear a clear conclusion on whether a tragedy of anticommons has occurred in any given field of research and innovation activity. For instance, looking at interaction between patent grants and diffusion of knowledge through scientific publications on 169 discoveries, Murray & Stern (2005) show that the granting of intellectual property rights is associated with a significant but modest decline in knowledge accumulation as measured by forward citations. More interestingly, two recent works (Walsh, Arora & Cohen, 2003; Walsh, Cho & Cohen, 2005) have collected several findings about agents' perceptions and practices in the biomedical research community for exchanging research tools and materials. While almost all the respondents

to the surveys reported that the institutional landscape has become more complex due to privatization pressures, the results provide little empirical basis for claims that restricted access to intellectual property is currently impeding biomedical research. In turn, only for access to tangible research materials and data, the authors find an increasing noncompliance with transfer requests. Crucially, it is important to notice that the actors in private firms, universities and non profit institutions reported to have adopted different strategies and “working solutions” to cope with the frictions generated by property rights proliferation. These includes inventing around blocking patents, going offshore, infringement under an informal research exemption, mutual non enforcement and cross-licensing agreements.

The perception that emerges from this preliminary evidence is that the quest for anticommons tragedies is hard for many reasons. First, in technology and innovation systems it is inherently difficult to conduct rigorous studies either of bargaining breakdown or of research projects abandonment and delays. Second, from a social welfare perspective, Walsh et al. (2005) point out that it is equally hard to assess whether the redirection of a scientist’s research effort or reallocation across investigators significantly reduces the chance of scientific progress or does favor a greater variety of projects. Third, while the theoretical models explaining the anticommons tragedy often rely on static efficiency, it is difficult to capture the social cost implied by this tragedy in a dynamic and evolving world where agents adapt their strategies (Alchian, 1950).

Notwithstanding these obstacles to the inquiry, the absence of a clear evidence does not necessarily lead to evidence of the absence of potential anticommons tragedies. Indeed, the arguments carried out by the critics of the anticommons tragedy in the field of research and innovation (Buckley, 2007; Epstein & Kuhlík, 2004) are equally hard to be proven. For instance, the up-growing trend experienced in knowledge intensive industries for many key variables of research activities and outputs (i.e. R&D spending, capital investments, number of research projects) is used as refuting evidence for anticommons tragedy. However, these variables may increase because the marginal benefits from investing (the discounted values of future returns) can be still higher than the actual marginal costs incurred by the new frictions of anticommons dynamics. Likewise, increase in R&D spending may be caused by greater research efforts in order to overcome the increasing difficulty in doing research.

3.2 Network governance structure: exclusion and strong ties vs. sharing and weak ties

The second layer of economic issues addresses governance structures for the management of information resources and technological innovation. How emerging research commons could perform in integrating knowledge and information resources as compared to other alternative structures? Knowledge is a very complex economic resource, whose nature poses several problems for its management. Both the natural uncertainty associated with innovation and the extent to which knowledge can be tacit, articulated or codified can substantially affect the division of innovative labor as well as the efficiency in exchanging the resource or appropriating its value (Arrow, 1962; Winter, 1987; Teece, 1988).

With this perspective, in the last two decades the literature has increasingly acknowledged networks and similar forms of collaborative ties as a governance structure distinct from market and firms. Dense networks of relational contracting occur in sectors where the organization of the innovation process is complex, resources are variable and the environment uncertain (Powell, 1990; Granovetter, 1993; Merges, 1995; Coombs, Richards, Saviotti & Walsh, 1996). According to Powell (1990), networks are the most performing systems, as compared to markets and hierarchical organizations, because they create incentives for learning and the dissemination of information, especially when dealing with intangible assets as tacit knowledge and technological innovation. Networks perfectly fit the transaction dynamics occurring in research communities, mainly because participants share a common background and possess fungible knowledge that is not limited to a specific task but applicable to a wide range of activities. Further, the advances in digital technology have enhanced the opportunity for interacting and exchanging information resources in a network-like form.

However, the dual equilibrium dynamics caused by privatization pressures seem to have generated two different forms of networks. On one hand, networks among firms and universities are observable in the formal zone of regulated access, where research and technological collaborations are a well documented phenomenon. This form of collaborative ties depends on exclusive rights and business models that use exclusion to appropriate the value of research outputs. In this case, the players in the formal zone often use knowledge protected by intellectual property rights as a bargaining chip for long term research cooperation. On the other hand, the dark zone of informal exchange of data, materials and research tools aims to circumvent the limitations of restrictive access imposed by privatization pressures. This system generates an informal networked commons, particularly suited for routine low value transactions. However, this system tends to be closed as it is

based on direct reciprocity, strong ties and long term collaborative relationships among the members of the research community. While this may be an effective system in exchanging resources for the parties involved, it may increase search costs and costs of mistakes in cumulative research.

The analysis of the formal and informal system of exchange highlights how knowledge dissemination and integration in networked environments is still based on exclusionary strategies and strong ties. This on the long term may create high entry barriers to prospective innovators and researchers or hinder the collective good of shared quality standards that favor cumulative research. In turn, effective and facilitated access to research tools, guaranteed materials and knowledge allows for the comparison of results, validation and replication of scientific findings. Then the question is how the existent governance structure in a networked environment could mitigate these problems?

Recent contributions looking at open source models of information production and exchange have highlighted new emerging conditions for distributing and integrating knowledge in a more open and weakly tied network organization. Arguably, this line of inquiry is particularly relevant to sustain the design of contractually based research commons. As noted by Benkler (2006), advances in digital technology and knowledge base is favoring a “commons based peer production” model for managing and disseminating knowledge. This organizational model based on sharing resources and outputs among widely distributed, loosely connected individuals who cooperate with each other within a decentralized, collaborative and non-proprietary framework. The basic conditions which make commons based production economic viable are similar to those identified for the emergence of relational networks, namely, when the productive process is characterized by high uncertainty, there is the need for exchange information that price signals or hierarchical mechanisms cannot provide, and when capital (i.e. human capital, creativity or fungible knowledge) is highly variable and diffused across the agents (Powell, 1990). However, the crucial difference between commons based peer production and relational networks lies in the fact that this new form of governance structure is based on non exclusionary strategies and weak tied network relationships. For instance, in commons-based peer production models the productive activity is coordinated by open source-like standard contractual regimes that allow for the dissemination of information resources to any would-be user. Further, commons based peer production does not presuppose any strong ties between agents. Crucially, the information resources - which is continuously shared, modified and improved by the users - is the real channel for communication between agents (Demil & Lecocq, 2006; Hope, 2008). Considering that innovation and learning are the two faces of R&D activity (Nelson, 1989), exclusion and strong ties are in-

stitutional mechanisms that mainly favor agents' appropriation of innovation and research output. By contrast, sharing resources in commons based peer production model enhance positive network externalities in cumulative research and favor learning effects among agents in the network.

Finally, it is also noted that the incentives for participating to common based peer production may diverge from the standard economic benefits of producing information in familiar governance structures. In this context, a set of indirect benefits and social rewards have been highlighted as the main factors for motivation. Indirect benefits, like hedonic gains or peer-reputation may improve rather than reduce people performance (Lerner & Tirole, 2002). With regard to social incentives, psychological and anthropological literature stresses that the weight a community put on social and economic rewards is a function of the cultural values associated with the actions (Hann, 1998; Fehr & Falk, 2002, e.g.). Economic factors are not the unique forces to determine benefits and costs of actions. On the contrary, social norms contribute in shaping different costs and benefits for individuals transactions. As a result, organization of activities in different contexts of social norms may not follow the same economic and social set of incentives.

3.3 Institutional change and mechanisms of expectations formation

A rather overlooked economic issue that can be of interest for understanding the effectiveness and future sustainability of emerging research commons is to look at the mechanisms that led to the expansion of property rights and exclusionary strategies by the actors involved in the research community. While many scholars, when dealing with the expanding boundaries of intellectual property rights, have recognized a set of changing norms, incentives and behaviors that increasingly led to the actual setting, it would be interesting to understand why and how this institutional setting has been reached through a self-sustaining system of shared beliefs and expectations.

One promising line of inquiry is indeed to study the evidence of a current detachment between the marginal value of research assets scattered among the many actors of the research communities and the expected high pay off (especially from downstream commercial applications) those holders perceive regarding their own resources (Heller & Eisenberg, 1998). On this matter, the economic literature concerned on the measurement of the value of information resources is far less optimistic about the high value the owners expect to extract from their assets, especially for genetic and biologic resources (Simpson & Sedjo, 1996; Frisvold &

Rubenstein, 2008, e.g.). The basic idea is that the total value of all the data and material collections put together is clearly high as a source of leads for research output and downstream commercial applications. However, individual agents and organizations in the research community will only consider the value of the marginal resource with respect to its potential use for research and commercial exploitation. In this case, the marginal value is likely to be low. If there is a wide number of potential sources, with approximately the same prospect of success and the same testing cost, all the resources are expected to be close substitutes. When numerous substitutes exist, the marginal value and the corresponding price of each will be low.

As a result, it seems that privatization pressures have come out from “cognitive biases” by the players in the research and innovation community. Eisenberg (2001) has clearly highlighted this stylized fact in the surveys conducted for the NIH Working Group on Research Tools. What emerge from this survey is that universities and biotechnology firms, which specialize in earlier stage discoveries, have often unrealistic expectations of making money from research tools, albeit these entities do not share in the full costs and risks of the complex process of drug discovery. At the same time, pharmaceutical firms, which have a broader view on the research pipeline, are less concerned in directly appropriating the value through collecting cash payments or garnering a share of future profits for outgoing research tools and materials. However, they put high value in research input used in the product development phase and for this reason set restrictive conditions to academic laboratories and biotechnology firms because of the fear of losing competitive ground.

The implication for the sustainability and viability of emerging research commons is straightforward. These initiatives provide indeed standard contractual mechanisms that are particularly suited for exchanging research assets still having unknown or likely low payoff as commercial applications. However, identifying resources with unknown or likely low pay off could be very difficult and biased by the cognitive biases described above. For this reason, the risk is that the same expectations for high value that led to the adoption of restrictive licensing strategy and privatization pressures could eventually undermine the willingness to adopt contractually based research commons.

With this perspective, initiatives for contractually constructed research commons have to be seen as institutional arrangements that nevertheless have to interact and compete with the current system of agents beliefs and expectations in order to be adopted. In this context, literature about institutions and institutional change (Coriat & Dosi, 1998; Aoki, 2001) may be useful to highlight specific dynamics such as adaptive behavior, collective action problems, path dependency

and agents' complex feedback mechanisms that can lead to the successful adoption of emerging research commons initiatives. However, this line of inquiry, particularly developed in generalized models or applied in other institutional domains, seems to still lack a wide application as for the "rules of the game" that govern research communities.

4 Concluding remarks: research commons in an evolutionary perspective

The paper has proposed a critical appraisal of the main economic issues concerning the proposal and design of contractually constructed research commons. These initiatives represent a step ahead in the debate which characterize the expansion of exclusionary and proprietary strategies in research and innovation activities. However, the main economic questions that address the necessity and viability of contractually based research commons are basically the same scholars have posed at the outset of the enclosure movement occurring to science and information resource for the last two decades. In the new scenario of proliferating exclusive rights are agents learning to use their contractual freedom to put forward research projects and innovation activities? Conversely, are there reasons to fear that transaction costs, strategic behavior and cognitive biases will stifle the opportunities for exchanging and integrating knowledge.

The three economic arguments presented in this paper try to respond to these questions and consequently address the necessity and future sustainability of contractually based research commons. The issue concerning the increased transaction costs and the evidence of an anticommons tragedy is probably a foundational one. In this context, two main facts emerge. First, although there is evidence of frictions caused by proliferating property rights and exclusionary strategies, agents have already started adopting private arrangements to cope with the new restrictive legal rules. Arguably, these strategies represent alternative institutional solutions that will compete with the initiatives for adoption of contractually based research commons. Second, although there is little evidence of an anticommons tragedy, the works surveyed clearly show the emergence of an informal research commons based on informal research exemption, mutual non enforcement or simply transactions taking place without entering into any formal legal undertakings.

This latter point is particularly relevant for justifying contractually based research commons as a new governance structure in research activities based on a weakly tied network organization of exchanges. Indeed, the theoretical examina-

tion of commons based peer production models described in the second economic argument points out the benefits for formalizing the informal commons through standard contractual regimes. Further, it also highlighted how this new form of governance structure could be effective in promoting the dissemination of knowledge under social sharing mechanisms.

However, this optimism has to find a balance with the third economic issue, which concerns institutional change and mechanism of expectation formation. As noted before contractually based research commons represent new institutional arrangement that lower the frictions for the exchange of research assets. For this reason, they will have to interact and compete with the other institutional mechanisms developed by agents and that are currently at play for favoring transactions. As the dynamic of institutions and institutional change is deeply rooted in the system of agent's beliefs and expectations, path dependence and collective action dynamics will inevitably affect the adoption and long standing viability of research commons initiatives.

One of the main challenge is therefore to understand whether the increasing adoption of exclusive strategies can be reverted by changing the system of agent's belief and expectation that have generated the domino effect towards the enclosure movement. Putting contractually based research commons in a comprehensive evolutionary perspective suggests that these initiatives are endogenous responses occurring into the complex ecology of research and scientific activity. As a result, imitative dynamics may be relevant even if small groups among the research communities start adopting or constructing contractually based research commons.

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