The Darkest Hour: Private Information Control and the End of the Democratic Science[1]

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Harvard University

Roberto Caso

University of Trento – Faculty of Law – LawTech Group

Abstract

The evaluation of scientific research is based on data protected by secrecy and intellectual property (e.g., Elsevier Scopus or Clarivate Web of Science). The peer review process is essentially anonymous. While science has progressed thanks to public dialogue, the current evaluation system is centered on private information control. This represents a fundamental shift from democratic to authoritarian science. Open Science may contrast this change only if it is accepted as the heir, in the digital age, of the values and principles that public and democratic science has traditionally fostered in the age of printing, thus becoming the guardian of a democratic society.

Contents. 1. Democratic science, public dialogue and intellectual property. 2. Private information control and authoritarian evaluation of science. 3. Open Science as public and democratic science

1. Democratic science, public dialogue and intellectual property

Can the scientific community be defined as democratic? Does science thrive only in a democratic society?

To answer properly these questions, it becomes essential to provide a definition of democracy, which is what two foremost scholars in this subject, Robert Merton e Michael Polanyi, have done.

Merton elaborated his renowned theory on informal norms that govern science since late 1930s, in times featured by totalitarian regimes[2]. The main concept behind it is that science flourishes in a democratic system and echoes some of its establishments.

[1] An earlier Italian version of this paper entitled «L'ora più buia: controllo privato dell'informazione e valutazione della ricerca» was presented at the AISA Conference «La scienza come ignoranza degli esperti e il governo del numero», held at the University of Pisa on March 16, 2018 http://aisa.sp.unipi.it/longo2018_testi/; http://aisa.sp.unipi.it/video-pisa2018/ and was later submitted to the Italian law review *Rivista Critica del Diritto Privato* (preprint available at ZENODO: https://doi.org/10.5281/zenodo.1228056). I would like to thank all the participants of that conference, particularly Maria Chiara Pievatolo of the University of Pisa and Giuseppe Longo of the École Normale Supérieure of Paris for discussing with me the interplay between science and democracy. I also thank Giulia Dore of the University of Trento for the English translation of the original text.

In his important work of 1942 Merton describes the norms of science[3]: universalism, communism (and originality [4]), disinterestedness and organized skepticism.

Universalism, which is a feature of democracy, imposes that scientific truth results from the application of established impersonal criteria[5]. It is not the personal status that defines the truthfulness of someone's statements, but the fact that scientists respect some predetermined criteria. Race, nationality, religious beliefs, social status are all irrelevant. Scientific career is open to anyone that can undertake it. Regardless of how imperfectly it is practiced, universalism is one of the fundamental principles of democracy.

> Impersonal criteria of accomplishment and not fixation of status characterize the open democratic society. Insofar as such restraints do persist, they are viewed as obstacles in the path of full democratization. Thus, insofar as laissez-faire democracy permits the accumulation of differential advantages for certain segments of the population, differentials that are not bound up with demonstrated differences in capacity, the democratic process leads to increasing regulation by political authority. Under changing conditions, new technical forms of organization must be introduced to preserve and extend equality of opportunity[6].

Communism, in its a-technical and wide meaning of communal property of goods, means that scientific progress results from social collaboration and belongs to the community.

> The communal character of science is further reflected in the recognition by scientists of their dependence upon a cultural heritage to which they lay no differential claims. Newton's remark - «If I have seen further it is by standing on the shoulders of giants» - expresses at once a sense of indebtedness to the common heritage and a recognition of the essentially cooperative and selectively cumulative quality of scientific achievement[7]. [...]

> The communism of the scientific ethos is incompatible with the definition of technology as «private property» in a capitalistic economy. Current writings on the «frustration of science» reflect this conflict. Patents proclaim exclusive rights of use and, often, nonuse. The suppression of invention denies the rationale of scientific production and diffusion [...]. Responses to this conflict-situation have varied. As a defensive measure, some scientists have come to patent their work to ensure its being made available for public use[8].

Peer acknowledgment is equally important for scientists. This explains well the norm on originality that drives the scientist to claim for the priority of his contribution to the progress of science. Disputes over priority indeed originate from the institutional relevance of originality.

Disinterestedness implies that scientists are only driven by the aim of searching for the truth.

Organized skepticism leads to the abeyance of any actual judgment on published results and to the critical evaluation, through logical and empirical criteria, of certain believes in a given time.

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[2] R.K. MERTON, *Science and Social Order*, in *Philosophy of Science*, 5, 1938, 321; ID., *Science and Technology in a Democratic Order*, in *Journal of Legal and Political Sociology*, 1, 1942, 115, republished in R.K. MERTON, *The Sociology of Science. Theoretical and Empirical Investigations*, edited and with an introduction by N.W. STORER, Chicago and London, 1973, 267; ID., *Priorities in Scientific Discovery: A Chapter in the Sociology of Science*, in *American Sociological Review*, vol. 22, no. 6, Dec., 1957, 635; ID., *The Matthew Effect in Science*, in *Science, New Series*, vol. 159, no. 3810, Jan. 5, 1968, 56; ID., *The Matthew Effect in Science, II: Cumulative Advantage and the Symbolism of Intellectual Property*, in *Isis*, vol. 79, no. 4, Dec., 1988, 606.

[3] R.K. MERTON, *The Sociology of Science. Theoretical and Empirical Investigations*, 267.

[4] Originality is discussed in the paragraph dedicated to communism.

[5] R.K. MERTON, *The Sociology of Science. Theoretical and Empirical Investigations*, 270 ff.

[6] R.K. MERTON, *The Sociology of Science. Theoretical and Empirical Investigations*, 273.

[7] R.K. MERTON, *The Sociology of Science. Theoretical and Empirical Investigations*, 274-275.

[8] R.K. MERTON, *The Sociology of Science. Theoretical and Empirical Investigations*, 275.

The communitarian feature depends on the institutional commanding of public communication of scientific research outputs. There is some sort of balance between the originality, on the one hand, and the communism, on the other. Competitive cooperation of scientists precisely moves around this delicate balance.

In other words, Merton finds in universalism a principle that is shared by democratic politics and the scientific community. Merton refers to a socialist idea of democracy, which is aimed at promoting substantial equality. Another fundamental aspect of the Mertonian thought is represented by the peculiar emphasis on the public nature of science. Publicity is key to the pooling of scientific research, but it also represents the prerequisite for originality. There cannot be originality unless there is memory and awareness of the state of the art. Finally, publicity becomes the vehicle to carry out organized skepticism.

From a liberal perspective, Michael Polanyi offers his own vision of scientific community and its interaction with the State[9].

Like in the Mertonian reasoning, there is a clear connection between the way science is organized and the political structure of society. However, in Polanyi the main idea is that the best possible organization hinges on the spontaneous coordination of individuals who choose autonomously what problems they want to solve. In Polanyi's analysis, science and the market – archetype of an organization based on spontaneous individual initiatives – well exemplify the existence of a superior principle that imposes to respect individuals' freedom.

> What I have said here about the highest possible co-ordination of individual scientific efforts by a process of self-coordination may recall the self-co-ordination achieved by producers and consumers operating in a market. It was, indeed, with this in mind that I spoke of 'the invisible hand' guiding the co-ordination of independent initiatives to a maximum advancement of science, just as Adam Smith invoked 'the invisible hand' to describe the achievement of greatest joint material satisfaction when independent producers and consumers are guided by the prices of goods in a market. I am suggesting, in fact, that the co-ordinating functions of the market are but a special case of co-ordination by mutual adjustment. In the case of science, adjustment takes place by taking note of the published results of other scientists; while in the case of the market, mutual adjustment is mediated by a system of prices broadcasting current exchange relations, which make supply meet demand.
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> But the system of prices ruling the market not only transmits information in the light of which economic agents can mutually adjust their actions, it also provides them with an incentive to exercise economy in terms of money. We shall see that, by contrast, the scientist responding directly to the intellectual situation created by the published results of other scientists is motivated by current professional standards[10].

In science every scientist should be free to choose which problem he wants to solve. The Republic of Science therefore appears like a system featured by an indisputable association of independent initiative and this aims at an unspecified goal[11]. Spontaneous coordination requires scientific publications, where each scientist takes account of his peers' publications and reacts with his own publications[12].

No single scientist is personally responsible for the progress of science, which is instead the result of many contributions from distinct areas of research[13].

The Republic of Science is governed and justified by the inherent respect towards tradition and value of scientific contribution, but at the same time it remains dynamic because existing knowledge may be challenged by new original results. Respect for authority and tradition and

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[9] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, in *Minerva*, 1, 1962, 54, http://sciencepolicy.colorado.edu/students/envs_5100/polanyi_1967.pdf

[10] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, 2 pdf.

[11] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, 10 pdf.

[12] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, 2 pdf.

[13] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, 3, 8 pdf.

for the value of scientific contributions is counterbalanced by the originality wish that drives towards progress[14].

No external authority can take the place of science in deciding its aims. Science only responds to its own authority, which arises from the mutual acknowledgement of peers. Such authority is transmitted from one generation to another thanks to the informal involvement in the scientific community. In other words, scientific method may not find an explicit explanation – as it is not entirely codified – and can be only transmitted through the apprenticeship of a pupil following the lead of his master[15].

Although there are differences in terms of prestige among scientists, the authority of science really depends on the reciprocal acknowledgment of the members of its community and not on a mere hierarchical order. Public or private funding to science should be only guided by merit, determined by the scientists themselves, diverting research funds to the most prestigious areas of research[16]. Universities should be left free to compete and choose the best scientists. Universities, therefore, become the best place for scientists to assemble in secluded communities and conduct research without any actual contribution by the public that does not have the necessary knowledge to take part in this process.

In Polanyi's metaphor: the Republic of Science is extraterritorial as it must guarantee that its set of rules is based only on scientific merits[17]. The Hungarian scientist moved his criticism to the politics of science that were being outlined in the United Kingdom at that time. These politics wished the State to guide scientific research for social aims (what today is known as «third mission») particularly when, after the end of the Second World War, the expansion of universities was essentially driven by public funds[18].

The liberal approach of Polanyi rotates around the principle of autonomy. Autonomy of the individual scientist, who is free to determine his own lines of research, and autonomy of universities from the State, which had only the role of funding the institutions that deserved it. Polanyi does not mention the word «democracy» but uses instead the term «republic». Consequently, science only responds to science.

Despite the obvious differences in terms of ideological perspective and understanding of democracy, Merton e Polanyi' theories share some important similarities.

a) Norms of science are informal.

b) There is a tension between the esteem for consolidated knowledge and its criticism, which is aimed at targeting new and original results.

c) Scientific dialogue is public.

This last statement requires further analysis. The public nature of scientific dialogue is a fundamental aspect of the scientific community. From Gutenberg onwards, talking about public dialogue means publishing printed works. Printing reduces time and distance; it also helps accumulating scientific knowledge. Moreover, publicity through printing is an essential element of modern democracies. The democratic or republican nature of science is intimately linked to the practice of printing the outputs of scientific research.

Besides, modern science has historically developed by promoting public scientific dialogue and the printing press has played a fundamental role in the process of institutionalizing such public nature of science.

Historian of science Paolo Rossi effectively portrayed the progressive affirmation of public and universal feature of science.

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[14] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, 3 pdf.
[15] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, 8 pdf.
[16] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, 4 pdf.
[17] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, 7 pdf.
[18] M. POLANYI, *The Republic of Science: Its Political and Economic Theory*, 6 pdf.

> Scientific theories must be entirely conveyable, and experiments be reproducible […]
> In this «darkness of life», as Leibniz will say, we must proceed together because the scientific method is far more important than individual genius and because the scope of philosophy is not to boost the individual mind but the minds of all mankind […]
> The battle for universal knowledge, comprehensible by many and by many carved out, was destined to progress, already in the seventeenth century, from the level of ideas and intellectual projects to the one of institutions. […][19]

Among the richest analysis of such process of institutionalization, in which scientific academies flourished, the one by Adrian Johns deserves to be mentioned[20]. With respect to the practices of the Royal Society and the activities of printing and editing the first modern scientific periodical – the Philosophical Transactions was first published in 1665 – Johns describes the following.

> In practice, every experiment was a nexus between the reading of some texts and the writing and printing of others. […]
> Experimenting with print as well as with nature, the experimentalists created the distant origins of peer review, journals, and archives—the whole gallimaufry that is often taken as distinctive of science, and that is now in question once again in the age of open access and digital distribution. Above all, they gave rise to the central position that scientific authorship and its violation would hold in the enterprise. […]
> For facts to count, they supposedly had to be witnessed by an audience—ideally on repeated occasions. Their registration was therefore part and parcel of learned sociability. And their reading too was consequently not a private act, in principle, but a social gesture. […]
> In the Society itself, however, four relatively discrete stages characterized and shaped the conduct of reading. I have called these presentation, perusal, registration, and publication (which might well take place via correspondence rather than print)[21].

Therefore, printing press as an instrument of public dialogue had its effects also on the intellectual property of the scientist. On the one hand, the press reinforced the demands for textual appropriation, while on the other hand it limited the exclusive control over the scientific results obtained by the scientist.

Concerning the former aspect, the words of Walter Ong may here be recalled [22].

> Print encourages a sense of closure, a sense that what is found in a text has been finalized, has reached a state of completion. This sense affects literary creations and it affects analytic philosophical or scientific work[23].
> Print culture gave birth to the romantic notions of 'originality' and 'creativity', which set apart an individual work from other works even more, seeing its origins and meaning as independent of outside influence, at least ideally[24].

Regarding the latter aspect, when scientists publish a book or a scientific article they want to establish priority on the theory described in the text, which can be roughly defined in terms of claiming the paternity of the theory itself[25]. Exclusive control on information (paternity

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[19] P. ROSSI, *La nascita della scienza moderna in Europa*, Roma-Bari, 2007, 26-34. The English translation is mine.

[20] A. JOHNS, *Piracy. The Intellectual Property Wars from Gutenberg to Google*, Chicago and London, 2009.

[21] A. JOHNS, *Piracy. The Intellectual Property Wars from Gutenberg to Google*, 59-61.

[22] W.J. ONG, *Orality and Literacy. The Technologizing of the Word*, New York, 2005. From a law and literature perspective, see M. WOODMANSEE, P. JASZI (eds.), *The Construction of Authorship – Textual Appropriation in Law and Literature*, Durham,1994 (3rd printing 2006).

[23] W.J. ONG, *Orality and Literacy. The Technologizing of the Word*, 129.

[24] W.J. ONG, *Orality and Literacy. The Technologizing of the Word*, 131.

[25] P. ROSSI, *La nascita della scienza moderna in Europa*, 33-34: «It should be underlined that, after the first scientific revolution, in scientific literature and in the literature on science there is not and there can no longer be – contrarily to what has happened and still happens in politics – a positive evaluation or even praise of concealment. Concealing, namely not making public one's own opinions only means cheating or deceiving.

over the theory) is the result of an inevitable interaction of technology (printing press), informal norms of the scientific community and formal rules of the laws on intellectual property (copyright and patents).

Informal norms of science essentially target acknowledgement among peers. Naming a certain theory after a scientist, winning a scientific prize (like the Nobel) and being cited in others' works are all forms of peer acknowledgement. Mario Biagioli underlines the differences between scientific authorship according to informal norms of science and intellectual property as formally regulated by the law (copyright and patents)[26]. His theory, following the analysis offered by Merton, is that scientific authorship, according to the informal norms of science, does not concern rights but rewards, namely scientific acknowledgments (especially in terms of citations). A claim of scientific authorship is a declaration that concerns nature, not a personal utterance of the scientist. For this reason, it is not his property. The rewards connected to such claim do not originate from the State (as it is for intellectual property rights) but from a global community (science).

The formal norms of copyright impede exclusive control (monopoly) over ideas, fact and mere data of the scientific text. The laws on copyright, in fact, only afford exclusive control over the expression of the idea that flows into an original work of intellectual creation, while ideas, fact and mere data remain in the public domain. They may freely circulate and be used by many[27]. The law on patents impede exclusive control over scientific discoveries and theories, as well as mathematical methods that do not have industrial application[28].

The printing press guarantees a potential devolution of sources of knowledge. It creates not only the conditions for copyright but also for piracy. Indeed, it may lend itself to a massive reproduction that is not authorized by copyright owners[29]. The mechanisms for copyright protection have always been only partially effective, also due to their territorial nature. International intellectual property treaties may help, but they do not really impede unauthorized reproduction.

Besides, copyright law engages with printing technology through the principle of exhaustion (the right of distribution being exhausted after the first selling)[30]. According to this principle (also know as «first sale doctrine»), when the copy (material embodiment) of the intellectual work is sold, the right of its owner to control any further distribution (e.g. a subsequent selling) is exhausted and cannot be exercised any longer on that copy. This principle allows second hand markets to exist, for instance for used books, but also more generally justifies the legitimacy of lending books or donating them to the library. Property over the material object that embodies the intellectual work is however the prerequisite of

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Scientists, who represent a distinct community, may be forced to secrecy, but they must be really compelled to do so. When such constraint arises, they may react with protest or even resist it firmly. The word *of* in the expression 'laws of Kepler' does not imply a notion of property: it only reminds the greatness of the scientist memory. Secrecy, for science and within science, has simply become a disvalue». The English translation is mine.

[26] M. BIAGIOLI, *Rights or Rewards? Changing Frameworks of Scientific Authorship*, in M. BIAGIOLI, P. GALISON (eds.), *Scientific Authorship. Credit and Intellectual Property in Science*, London-New York, 2013, 253.

[27] For essential references of US literature, see. J. BOYLE, J. JENKINS, *Intellectual Property: Law & Information Society*. *Cases & Materials*, Third Edition, 2016, 320 ff.

[28] See J. BOYLE, J. JENKINS, *Intellectual Property: Law & Information Society*. *Cases & Materials*, 653 ff.

[29] See, for instance, what Adrian Johns says regarding the unauthorized printing of the Philosophical Transactions. A. JOHNS, *Piracy. The Intellectual Property Wars from Gutenberg to Google*, 63: «Its success may well have depended, in fact, on the unauthorized reprints that Oldenburg ostentatiously sought to suppress. Continental philosophers responded, both to them and to his original. They embraced the initiative, and their contributions sustained the Society itself as the fervor of its local membership inevitably waned. In those terms the Philosophical Transactions proved astoundingly successful».

[30] A. PERZANOWSKI, J. SCHULTZ, *The End of Ownership. Personal Property in the Digital Economy*, Cambridge (MA), 2016.

secluded reading, a fundamental aspect of privacy and self-determination in the individual cultural education[31].

The interaction of technology (printing press), informal norms of science and intellectual property law changes the way public debate over science may evolve and knowledge may pass from one generation to another.

The pressure to publish, driven by the priority rule, does not entirely expunge the trend of private control over knowledge. As a scientist I should be able to decide whether I want to publish only some of my research results and keep other research data secret or, in alternative, to postpone publication to get competitive advantage among peers. However, I may not turn down publication entirely. Since the printing revolution dialogue among scientists and between scientists and citizens is essentially of a public nature.

«Academic copyright», to be understood not only as a prerogative conferred by the State, but as an interaction of technology, informal norms of science and formal copyright law, is the prerequisite for public dialogue in the scientific community and democratic society. Their interaction is clearly complex and the friction between norms of science and copyright is often inevitable. However, copyright law may foster the free development of public debate over science. It does this conferring an exclusive right to the author and not to the institution to which he belongs: the scientist speaks for science and not on behalf of his employer. And he does it leaving ideas in the public domain.

The stringent relationship that connects copyright, freedom of expression, public dialogue and democracy is endorsed by both jusnaturalistic theories that justified copyright[32] and theories that justify copyright protection based on the effects that it has on society[33].

In Italy, Maria Chiara Pievatolo has promoted a Kantian vision of copyright and public dialogue in science[34]. The author makes a public use of reason[35] asking the publisher to represent him in his debate with the public[36]. Only the public use of reason may brighten people minds and create a community of knowledge. Socratic philosophy and modern science share the idea that community grows and prospers by building on knowledge through public dialogue[37].

2. Private information control and authoritarian evaluation of science

When Merton and Polanyi discussed the democratic nature of science, the latter was evolving considerably. It was turning from small science to «big science». The deployment of large public funds, the increased circulation of researchers and the greater spread of publications became an important feature of big science. At the same time, intellectual property started to be increasingly relevant for scientific research[38]. Universities were becoming more organized

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[31] W. J. ONG, *Orality and Literacy. The Technologizing of the Word*, 128.

[32] A. DRASSINOWER, *A Rights-Based View of the Idea/ Expression Dichotomy in Copyright Law*, in *Canadian Journal of Law and Jurisprudence*, Vol. 16, January 2003. SSRN: https://ssrn.com/abstract=418685

[33] N. W. NETANEL, *Copyright and a Democratic Civil Society*, in *The Yale Law Journal*, Vol. 106, No. 2 (Nov., 1996), 283; W. FISHER, *Theories of Intellectual Property*, in S. MUNZER (*ed.*), *New Essays in the Legal and Political Theory of Property*, Cambridge, 2001, [p. 4 pdf] https://cyber.harvard.edu/people/tfisher/iptheory.pdf

[34] M.C. PIEVATOLO, *I padroni del discorso. Platone e la libertà della conoscenza*, Pisa, 2003, http://bfp.sp.unipi.it/ebooks/mcpla.html; F. DI DONATO, *La scienza e la rete – L'uso pubblico della ragione nell'età del Web*, Firenze, 2009, http://www.fupress.com/archivio/pdf/3867.pdf

[35] I. KANT, *An Answer to the Question: What is Enlightenment?* (1784), in M. J. GREGOR, A. WOOD (eds.), *Practical Philosophy* (*The Cambridge Edition of the Works of Immanuel Kant*, pp. 11-22), Cambridge, 1996.

[36] I. KANT, *On the Wrongfulness of Unauthorized Publication of Books* (1785), in in M. J. GREGOR, A. WOOD (eds.), *Practical Philosophy* (*The Cambridge Edition of the Works of Immanuel Kant*, pp. 23-36), Cambridge, 1996.

[37] M.C. PIEVATOLO, *I padroni del discorso. Platone e la libertà della conoscenza*, cit., 35 ff., 80 ff.

[38] A. JOHNS, *Pirateria – Storia della proprietà intellettuale da Gutenberg a Google*, cit., 521 ff.

and more like enterprises, even engaged in legal battles over patent protection. There were years in which the boundaries between public and private, basic research and applied research started to fade. This phenomenon was even more obvious in the United States. In such context bibliometrics turned to be an extraordinary profitable deal.

Eugene Garfield, a scientist but also a business man, founded in the 1960s the Institute of Scientific Information (ISI) – now property of Clarivate Analystics, a private company, destined to play a fundamental role in the govern of science.

What were the theoretical premises that brought to the foundation of the ISI enterprise? Garfield wanted to build a system of bibliographical search that would allow scientists to find the most relevant and reliable sources, namely scientific articles and other important publications of the past[39]. The idea was to measure how much an article could be a potential relevant source to be cited in other papers. It was necessary to build a citation index that could determine the «impact factor» of each article that appeared in a closed list of scientific journals. This idea was supported by the sociology of science and in particular by Derek De Solla Price who measured the citation of journals to determine their importance[40].

The theoretical premise of these studies was the Mertonian theory on scientific peer acknowledgment and the fact that citations do not uniformly circulate as they only focus on some authors that for this reason acquire a competitive advantage against their peers, inducing the so-called «Saint Mattew effect», which recalls the verse of the New Testament (Mattew 13: 12) that says: «For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken away even that which he hath»[41]. It appears pertinent to notice that one of the sources used by Garfield was the Shepard's Citations, the citation index used by US lawyers to get a first look at the judicial precedents and understand whether a given case was followed or otherwise questioned by subsequent case law.

Among the reasons behind this idea there was the identification of a list of «core journals» to Science Citation Index (SCI). According to Jean Claude Guédon:

> Garfield's pragmatic solution to a thorny problem—namely finding ways to manage the tracing of thousands upon thousands of citations—carried with it a very large theoretical consequence. In merging all sorts of little specialty cores that had been culled from the coverage of leading bibliographies, and from interviews of many key scientists, Garfield, in effect, gave substance and reality to a new notion, that of «core journals» for «core science». What used to be a useful tool to assist in making difficult choices had become a generic concept with universal claims. «Core science» suddenly existed and it could be displayed by pointing to a specific list of publications[42].

The ISI developed some of the criteria to identify such list, but most of all it created a new index that officialized the concept of «impact factor», which Garfield had already mentioned in 1955. Garfield defines the Impact Factor (IF) as the measure of the frequency of citation of the «average article» in a journal in a particular year or period[43].

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[39] E. GARFIELD, *Citation Indexes for Science: A New Dimension in Documentation through Association of Ideas*, *Science* 15 July 1955: Vol. 122 no. 3159, 108, DOI: 10.1126/science.122.3159.108.

[40] D.J. DE SOLLA PRICE, *Networks of Scientific Papers*, *Science* 30 July 1965: Vol. 149 no. 3683, 510, DOI: 10.1126/science.149.3683.510.

[41] R. K. MERTON, *The Matthew Effect in Science*, in *Science,* cit.; ID., *The Matthew Effect in Science, II: Cumulative Advantage and the Symbolism of Intellectual Property*, cit.

[42] J.C. GUÉDON, *In Oldenburg's Long Shadow: Librarians, Research Scientists, Publishers, and the Control of Scientific Publishing*, Association of Research Libraries, 2001, 20http://www.arl.org/storage/documents/publications/in-oldenburgs-long-shadow.pdf

[43] E. GARFIELD, *The Impact Factor*, in *Current Contents*, 1994, 25, 3-4, on the Web site of Clarivate Analytics at: https://clarivate.com/essays/impact-factor/

Identifying the journals considered to be core has had an impact also on the choices of libraries that may not buy all sources of literature for obvious reasons of limited budget. The ISI played a fundamental role in influencing the library choices on subscriptions depending on the SCI or IF.

According to classic heterogenesis of intents, universities and research centers started using IF to evaluate their own researchers[44].

They began evaluating researchers that published on journals with a high IF and consequently researchers reacted publishing in these journals too. Bibliometrics had at that time become an instrument of evaluation rather than an instrument of research. A rule featured by mathematics and statistics.

The inner mechanism of citation databases and the measures associated to them has given a considerable power in terms of evaluation to ISI, only recently joined by other similar companies. Furthermore, core journals made the market of scientific publications essentially an oligopoly. The oligopolistic structure of this market depends on the fact that researchers want to publish on journals with higher IF and libraries tend to buy, also under the pressure of researchers (who are not directly paying for their price) such subscriptions. This inevitably makes demand inelastic, which means that it does not increase or decrease correspondingly with a fall or rise in its price, consequently creating barriers to enter the market and favoring mainly the big players of the publishing market[45]. These big publishers clearly are aware of the desirability of such market and their profits have objectively proved to be increasing, which had also facilitated mergers and acquisitions that considerably augmented their economic power. The market of scientific publications, in other words, is less than competitive and features instead a high level of confluence.

During the 1960s, times still dominated by traditional printing press, the power of evaluation began to be concentrated in the hands of few private companies, which built a complex system of secrecy and intellectual property around their business of distributing digital databases[46]. Private control over scientific databases is essentially characterized by the interaction of intellectual property law, contracts and technological protection measures (TPMs)[47]. Because of this control over information big oligopolistic enterprises based their commercial models on «bundling» subscriptions and «price discrimination». Indeed, the

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[44] J.C. GUÉDON, *In Oldenburg's Long Shadow: Librarians, Research Scientists, Publishers, and the Control of Scientific Publishing*, 21:
«Research centers and universities commonly use journal impact factors. Although pertaining to periodicals, this indicator finds itself applied to the case of individual scientists' performance, simply because the figures are published and, therefore, readily available [...]. However, this lazy approximation undermines the very meaning of the exercise. The quantitative side of impact factors connotes objectivity, of course. To some people, particularly science administrators, this connotation seems to be more important than the appropriateness of the method because it allows them to generate powerful forms of judgmental rhetoric. It also keeps everyone mesmerized on journal titles and relegates articles into the background. As we shall see, the interest of commercial publishers is to keep pushing journal titles, and not individual articles, as they are the foundation for their financially lucrative technique of branding individual scientists».

[45] AA. VV., *Study on the economic and technical evolution of the scientific publication markets in Europe* [Final Report – January 2006], http://ec.europa.eu/research/science-society/pdf/scientific-publicationstudy_en.pdf; G.B. RAMELLO, *Copyright & Endogenous Market Structure: A Glimpse from the Journal Publishing Market* (July 21, 2010), *Review of Economic Research on Copyright Issues*, Vol. 7, No. 1, 7, 2010, SSRN: http://ssrn.com/abstract=1646643

[46] V. LARIVIÈRE, S. HAUSTEIN, P. MONGEON, *The Oligopoly of Academic Publishers in the Digital Era*, PLOS ONE, 10(6) 2015, p.e0127502,
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0127502

[47] J.C REICHMAN., R. OKEDIJI, *When Copyright Law and Science Collide: Empowering Digitally Integrated Research Methods on a Global Scale*, 96 *Minnesota Law Review* 1362 (2012), Minnesota Legal Studies Research Paper 12-54. SSRN: http://ssrn.com/abstract=2149218

consequences of such centralized power of controlling sources of information and evaluation based on bibliometrics do not have a mere economic effect. The whole infrastructure of sources of scientific information is moving from the hands of scientific institutions and libraries to the hands of big market players.

However, this power of evaluation would not have existed without an alliance with some members of the scientific community, also known as the «gatekeepers», namely members of scientific boards, editors and reviewers of the journals that are mostly playing the game of evaluations[48].

Afterwards, such game started to put some leverage on the anonymous nature of peer review and then essentially filtered scientific publications[49]. In its many variables, anonymous peer review clashes with the public nature of scientific dialogue, provoking instead a strong hierarchy. Essentially, oligopolies that are hand in hand with oligarchies.

In closing this paragraph, it seems useful to draw some conclusions. Private control over information is, within the system of research evaluation, the instrument to concentrate «governance» powers and consequently lessen the democratic value of science.

In the market environment, private control over information endorses oligopolistic powers. Either we look at the example of ISI and similar initiatives or new Internet intermediaries like Google or scientific social networks like Academia.edu e ResearchGate – which sell private information in exchange of personal data – what really matters is to maintain exclusive control over the data that measure the indexes of evaluation.

3. Open Science as public and democratic science

Open Science (OS) is an umbrella term that encompasses many phenomena, including open software, open access publications, open research data and research reproducibility, open education (open access to educational resources), open peer review (namely the set of procedures that, in different ways, affirms the principle of public peer review), the use of evaluation metrics based on open data, the process of engaging citizens in obtaining scientific results («citizen science»)[50].

The foundations of OS can be identified in two aspects of the process of public creation of science.

The former is the free and open access, through the web, to scientific and educational resources. Open access means granting the public some rights like the right of reproduction, the right to create derivative works, the right of distribution, the right of communication to the public.

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[48] J. C. GUÉDON, *In Oldenburg's Long Shadow: Librarians, Research Scientists, Publishers, and the Control of Scientific Publishing*, 32.

[49] K. FITZPATRICK, *Planned Obsolescence. Publishing, Technology, and the Future of the Academy*, New York, 2011, 15 ff., 27 ff.

[50] AA.VV., *The Open Science Training Book*, 2018, https://open-science-training-handbook.gitbooks.io/book/content/; R. CASO, *Scienza aperta*, The Trento Law and Technology Research Group. Research Papers Series; nr. 32, Trento, 2017, https://iris.unitn.it/handle/11572/183528#.WqlWf73OUfM; B. FECHER, S. FRIESIKE, *Open Science: One Term, Five Schools of Thought*, in S. BARTLING, S. FRIESIKE (eds.), *Opening Science. The Evolving Guide on How the Internet is Changing Research, Collaboration and Scholarly Publishing*, Cham - Heidelberg – New York - Dordrecht – London, Springer, 2014, 17, https://link.springer.com/chapter/10.1007%2F978-3-319-00026-8_2; P. SUBER, *Open Access*, Cambridge (Mass.), 2012, https://mitpress.mit.edu/sites/default/files/9780262517638_Open_Access_PDF_Version.pdf; The ROYAL SOCIETY, *Science as Open Enterprise*, 2012, https://royalsociety.org/~/media/policy/projects/sape/2012-06-20-saoe.pdf; M. NIELSEN, *Reinventing Discovery. The New Era of Networked Science*, New Jersey, 2011; J. WILLINSKY, *The Access Principle. The Case for Open Access to Research and Scholarship*, Cambridge (MA), 2006, http://wiki.lib.sun.ac.za/images/0/03/The-access-principle.pdf

The latter is the transparency, through the web, of evaluation procedure and of the control over the production of scientific outputs.

In modern times a fortunate concurrence of political, economic and technological factors made possible the emergence of public (open) science. However, the institutional structure of public science – featured by an interaction of technology, informal norms and formal norms – was since the very beginning very fragile[51]. As illustrated in the previous paragraphs, private control over information may downsize or even destroy public and democratic science.

In this historical moment private control over information highly prevails and the actual survival of open science is at risk. This is confirmed by the fact that large commercial databases have invaded a considerable part of Open Access.

Elsevier, for instance, not only charges for OA, but is currently buying some repositories and digital infrastructure of OA like «Social Science Research Network» and «bepress». At the same time, scientific commercial social network like Academia.edu appear to be increasingly aggressive players on the market[52]. Scientific researchers, on the contrary, seems more interested to choose commercial platforms rather than using the infrastructures that exists in the academic institutional or nonprofit world. This even though scientific social networks share the same negative aspects that feature in the any other social networks, for example regarding the appropriation and exploitation of personal data of users[53].

These instances prove that, contrarily to what many think of Open Science - as it had an inescapable positive fate – there are some contrasting forces that work in the opposite direction.

1) «Centralization of the private control over information on the web». The dream of an open and democratic web clashes against the affirmation of today's web, which is dominated by big commercial platforms and public agencies that do not really operate for the sake of the public good[54].

2) «Automated decisions». Centralization of the private control over information matches the idea of substituting human decisions with algorithms and software. In its most extreme form this paradigm predicts the substitution of human science with the science of machines. Applying mathematics and statistics to large quantity of data («big data») would allow identifying correlations among different phenomena, with no need to turn to the classical

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[51] P. DAVID, *The Historical Origins of «Open Science». An Essay on Patronage, Reputation and Common Agency Contracting in the Scientific Revolution*, cit., 5. «Considered at the macro-level, "open science" and commercially oriented R&D based upon proprietary information together form a complementary pair of institutionally distinct sub-systems. The public policy challenge that needs to be faced, consequently, is to keep the two sub-systems in proper productive balance, so that the special capabilities of each may amplify the productivity of the other. But the former of these sub-systems, being based on cooperative behavior of researchers who are dependent on public and private patronage support for their work, is the more fragile of the pair; and the more likely to be undermined by the incursion of information disclosure restrictions motivated by the goal of privately appropriating rents from possession of new scientific and technical information. The "balancing act" for public policy therefore requires more than maintenance of adequate public funding for open science institutions and programs. It may call for deliberate measures to halt, and in some areas even reverse excessive incursions of claims to private property rights over material that would otherwise remain in the public domain of scientific data and information – in other words, for the protection of an "open science domain" from the regime of legal protections for intellectual property rights».

[52] J. POOLEY, *Scholarly communications shouldn't just be open, but non-profit too*, August 15, 2017, http://blogs.lse.ac.uk/impactofsocialsciences/2017/08/15/scholarly-communications-shouldnt-just-be-open-but-non-profit-too/

[53] K. FORTNEY, J. GONDER, *A social networking site is not an open access repository*, December 1, 2015, http://osc.universityofcalifornia.edu/2015/12/a-social-networking-site-is-not-an-open-access-repository/.

[54] T. BERNERS LEE, *Long Live the Web*, in *Scientific American*, 2010, 80.

scientific method based on hypothesis and theoretical models that can be subject to falsification[55].

3) «Intellectual property laws increasingly broad». In particular, the protection of database and TPMs distort copyright and make it closer to a perilous property of information[56].

4) «Commercialization of science and university». The transformation of universities into enterprises is dated back to the few past decades. However, recently this process has suffered an extraordinary speed[57]. Universities make a strategic use of intellectual property and act like the main actors of the technology market. The distinction between basic research and applied research seems to fade. Research funding appears to be often project based and linked to short term results. Informal norms of science change and are often substituted by formal forms. Research become temporary and unstable, which reduces the autonomy and the freedom of researchers, particularly younger researcher who we should expect to pursue new ideas. Language and categories of the institution change, together with the dominion of «qualitative evaluation». Commercialization is accompanied by competition at the detriment of cooperation among scientists. One of the collateral effects of such exacerbation of competition is the exponential grow of scientific misconduct[58].

5) «A less democratic society». The transition from the rule of the law to the governance of numbers well describes the crisis of Western democracy[59]. What seems to be a relentless transformation of democracy into a «soft authoritarianism», namely the compression of the autonomy of science and academic freedom, is indeed a fundamental aspect of this process. As history has clearly demonstrated, authoritarianism fears democratic science because it is the perfect environment for the critical thought to develop.

To survive and hopefully further develop, open science must fight against all these forces.

Regarding intellectual property law, to date the petitions of open science have not really be found their own space. On the contrary, it is unlikely that they will. This is well explained by the fact that part of the OS movement chose instead civil disobedience seeking a circumvention of copyright law to release scientific knowledge from exclusivity. In his foremost post of 2008 titled «Guerrilla Open Access Manifesto» Aaron Swartz urged to exchange passwords to access proprietary databases, to share papers downloaded for a fee using the peer-to-peer (P2P) technology[60]. Swartz's message found some systematic fulfillment in platforms like Sci-Hub, where an enormous quantity of scientific publications is available.

Civil disobedience diminishes private control over information but does not really solve the problem. It is rather necessary to discuss the predicament of the evaluation systems that are currently ruling.

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[55] C. ANDERSON, *The End of Theory: The Data Deluge Makes the Scientific*, in *Wired*, 27 giugno 2008, https://www.wired.com/2008/06/pb-theory/https://www.wired.com/2008/06/pb-theory/. For some criticisms, see C. S. CALUDE, G. LONGO, *The Deluge of Spurious Correlations in Big Data*, in *Foundations of Science*, 2017, vol. 22, Issue 3, 595.

[56] J.C REICHMAN, R. OKEDIJI, *When Copyright Law and Science Collide: Empowering Digitally Integrated Research Methods on a Global Scale*.

[57] See, for example, E. SCHRECKER, *The Lost Soul of Higer Education, Corporatization, The Assault on Academic Freedom, and the End of American University*, New York-London, 2010; H. RADDER (ed.), *The Commodification of Academic Research*, Pittsburgh Pa., 2010.

[58] M.A. EDWARS, S. ROY, *Academic Research in the 21st Century: Maintaining Scientific Integrity in a Climate of Perverse Incentives and Hypercompetition*, in *Environmental Engineering Science*, Volume 34, Number 1, 2017, DOI: 10.1089/ees.2016.0223, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5206685/

[59] A. SUPIOT, *Governance by Numbers. The Making of a Legal Model of Allegiance*, London, Oxford, New York, New Deli, Sydney, 2017.

[60] A. SWARTZ, *Guerrilla Open Access Manifesto*, July 2008, Eremo, Italy, https://archive.org/stream/GuerillaOpenAccessManifesto/Goamjuly2008_djvu.txt

Open Science may help hindering the centralization of evaluation powers only if it becomes aware of the fact that, in the digital age, it has become the heir of all the values and principles that public science has traditionally fostered in the analogic age. This also means that open science represents one of the most important strongholds of a truly democratic society.

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