Essay in MNSES9100 - Céline Cunen

The impact of Philosophy of Science: a citation analysis

Both the name and common definitions of Philosophy of Science (hereafter PoS) suggests this branch of philosophy aims at having an impact on science. But to what extent are scientists actually interested in PoS? In this essay I will investigate this question by means of a citation analysis.

PoS deals with "the nature of science, conceptual and methodological analysis, and science criticism" (Pigliucci, 2008). This includes both descriptive approaches, where the philosophers of science describe how science actually proceeds, and normative traditions, where the philosophers aim at instructing scientists on how science ought to be done. Other areas of PoS deal with the historical use and clarification of concepts within the sciences, and with investigating how research findings are understood by the general public and used in politics (Pigliucci, 2008). Given this definition, there seems to be plenty of questions within PoS that could interest scientists. In fact, some philosophers of science believe that science and PoS "should be strongly interacting" (Gale, 1984) and even claim that the clarification of theoretical concepts by PoS can contribute to scientific progress (Hull, 2000). The famous physicists Albert Einstein considered PoS as a way to liberate the scientist's imagination (Lewens, 2015): "A knowledge of the historic and philosophical background gives that kind of independence from prejudices of his generation from which most scientists are suffering. This independence created by philosophical insight is - in my opinion - the mark of distinction between a mere artisan or specialist and a real seeker after truth" (Einstein, 1944).

However, contemporary scientists with positive attitudes towards philosophy, like Einstein's, may be exceptions, rather than the rule. According to Gale (1984) PoS seems irrelevant to most scientists, and the relationship between scientists and philosophers of science is marked by mutual disdain. Hull (2000) adds that philosophers are for the most part ignored by scientists. In recent years, several prominent physicists have expressed their dissatisfaction with philosophy in general, and PoS especially. Nobel laureate Steven Weinberg devoted an entire chapter in his book *Dreams of a Final Theory* (1992) to argue against philosophy (Weinberg, 1992, Against Philosophy). He claims that scientists

cannot expect any guidance from philosophy and that the contributions from PoS have even harmed the progress of science in some instances. The even more famous Stephen Hawking writes that "philosophy is dead" and that it has not "kept up with modern developments in science, particularly physics" (Hawking & Mlodinow, 2010). Lawrence Krauss is possibly even more critical when he states "And the worst part of philosophy is the philosophy of science; the only people, as far as I can tell, that read work by philosophers of science are other philosophers of science. It has no impact on physics what so ever, and I doubt that other philosophers read it because it's fairly technical." (Andersen, 2012).

In this essay I wish to investigate the claim made by Krauss; to what extent is recent work by philosophers of science read and subsequently cited by scientists? Are PoS articles cited by people outside the field at all? The impact of PoS on the sciences could have been investigated in several manners, but citations are a principal measure of influence in academia and the data for citations analyses are generally easily obtained. The hypothesis is that if scientists indeed find PoS irrelevant there should be no, or few, citations of PoS articles in articles printed in science journals. In the discussion I will also approach the more fundamental question concerning the role of PoS as defined by philosophers of sciences themselves. To what extent do they want to influence science?

Data and Methods

Wray (2010) identified the six key journals for publishing PoS articles. Two among these, *Journal of Philosophy* and *Synthese*, are better considered as journals of general philosophy (Wray & Bornmann, 2015) and I did not include them in my list of PoS journals. The four remaining journals are *Philosophy of Science*, *British Journal for the Philosophy of Science*, *Erkenntnis* and *Studies in History and Philosophy of Science*. The last journal is published in three parts, and I treated these three parts as separate journals: *Part A*, *Part B - Studies in History and Philosophy of Modern Physics* and *Part C - Studies in History and Philosophy of Biological and Biomedical Sciences*; giving me six PoS journals (see Table 1). A total of 2076 articles were published in these six journals in the six years between 2010 and 2015, and I collected information on all the articles or books citing these 2076 articles from the Scopus database (by Elsevier). This gave me 3816 citations from 771 different scientific journals.

In order to classify the 771 journals (and ultimately the citations themselves) into scientific fields I made an R script (R Core Team, 2000) looking up each journal in the Serial Title API (Elsevier). An API (Application Program Interface) is a service providing

easy access to an application, a database in this case, for computer programs. This made it possible to retrieve subject information enabling the classification of the journals into 16 categories corresponding to scientific fields (see Figure 1). Among the 3816 citations 290 were from books. I chose to disregard books in my analysis since it was more difficult to classify them automatically into subject categories, and I thus consider the 3526 remaining citations in the rest of this essay.

Results: who cites philosophy of science?

Articles from the six key PoS journals were thus cited 3526 times and these citations are distributed into different fields as shown in Figure 1. The majority of the citations come unsurprisingly from philosophy and PoS itself (67%). However a non-negligible portion of the citations are found in science journals (20%). Among the sciences, the fields citing most PoS articles are biology, medicine (a large category including health studies, dentistry and other related fields) and physics. Table 1 displays differences between the PoS journals when it comes to the number of citations and the percentage of "their" citations found in science journals. *Erkenntnis* is little cited by the sciences, but has most of its citations in philosophy (both PoS journals and other branches of philosophy). *Studies in History and Philosophy of Science Part B* and *Part C* are the two journals who are the most cited by the sciences (relative to their number of citations).

Journal	% in Sciences	% in Philosophy	n
Philosophy of Science	14	73	1010
British Journal for the Philosophy of Science	20	70	591
Erkenntnis	10	81	350
Studies in History and Philosophy of Science Part A	12	71	572
Studies in History and Philosophy of Science Part B	41	51	372
Studies in History and Philosophy of Science Part C	28	52	631

Table 1: Percentage of citations within science journals and philosophy journals for the six PoS journals considered. "n" is the number of citations for each journal.

Tables 2 and 3 list the journals citing the most PoS articles, among all journals and among science journals only. As expected from Figure 1, the journals in Table 2 are almost exclusively within PoS or general philosophy. *Biology and Philosophy* may be considered an exception, since it is both a biology and philosophy journal. The journals in Table 3 belong to various fields, mostly physics and biology. Note that the journal *Perspectives on Science* was classified into the multidisciplinary science category, but is actually a Science Study journal and should have been placed among humanities or social sciences, rather than among the sciences. Some degree of misclassification must be expected.

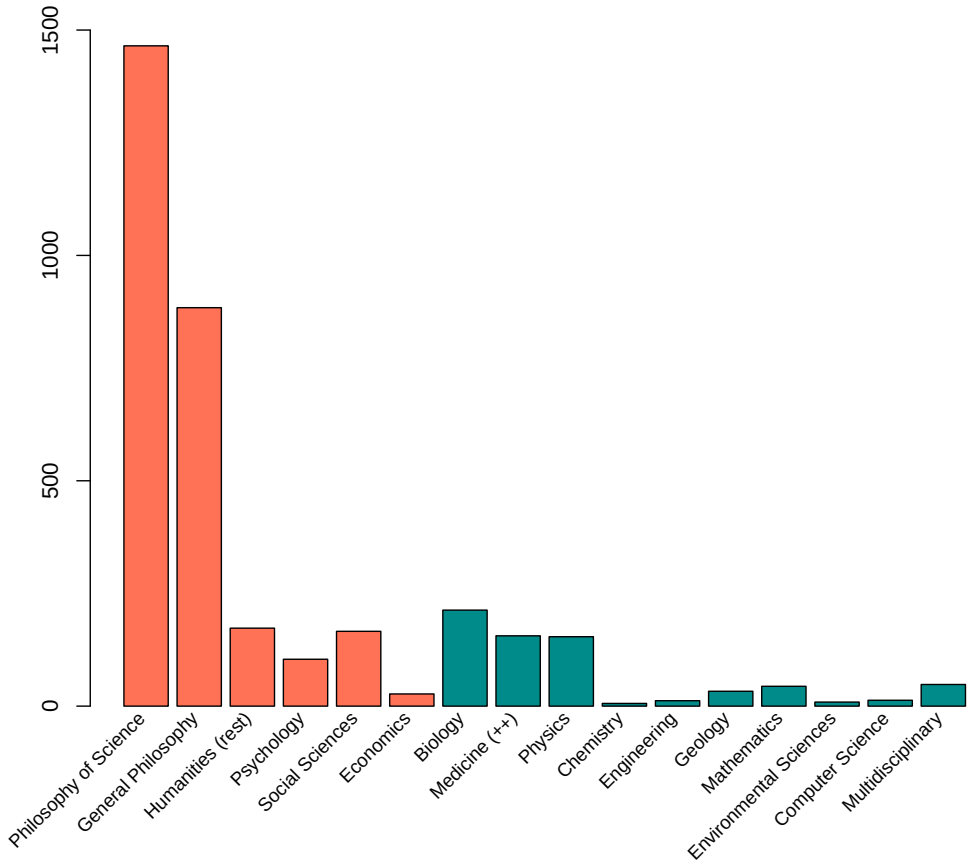

Figure 1: Number of citations of PoS journals in different scientific fields. Red bars are fields within humanities and social sciences. The blue bars are sciences.

Discussion

The results from the citation analysis demonstrate that PoS articles are not exclusively cited by other PoS articles, but have a considerable proportion of citations in articles published in science journals. In order to assess whether 20% is a large or small proportion, I chose to do a similar analysis of citations within my own field, statistics. Statistics is a field in its own right, but has a role in relation to the sciences that is possibly comparable to the one of PoS. Both fields address methodological issues and have a certain normative aspect. I identified the four most important statistics journals according to the SJR indicator (SCImago Journal Rank); *Journal of the Royal Statistical Society - Series B: Statistical Methodology*, *Annals of Statistics*, *Journal of the American Statistical Association* and *Biometrika*. In the years between 2010 and 2015 these four journals published 1955 articles, and these articles were cited 12 878 times in 1754 different scientific journals. Most of these citations were within statistics itself or in neighbouring fields like

Journal	Number of citations
Philosophy of Science	254
Studies in History and Philosophy of Science Part C	221
Studies in History and Philosophy of Science Part A	207
Synthese	168
Studies in History and Philosophy of Science Part B	125
Erkenntnis	95
European Journal for Philosophy of Science	93
British Journal for the Philosophy of Science	87
Biology and Philosophy	82
Journal for General Philosophy of Science	52

Table 2: The ten journals citing the most PoS articles.

Journal	Number of citations
Foundations of Physics	41
Perspectives on Science	26
Theoretical Medicine and Bioethics	23
Physical Review D - Particles, Fields, Gravitation and Cosmology	15
Entropy	12
Journal of Evaluation in Clinical Practice	12
Interface Focus	11
PLoS ONE	11
Climatic Change	9
Journal of Experimental Zoology Part B: Molecular and Developmental Evolution	9

Table 3: The ten science journals citing the most PoS articles.

mathematics and computer science, but 25% were in other sciences[1]. Statistics journals thus have a higher proportions of citations in the sciences compared to PoS, but not very much higher. Although the proportions are not so different the number of citations is much larger for the statistics journals than for the PoS journals, even though the number of articles is roughly equal.

There are of course several limitations to my analysis. Ideally it should be extended in time to cover more years. Also note that the citations are collected on the journal level only and I do not have information on which articles in the journals the citations are citing. It could be interesting to study *which* types of articles in the PoS journals attract the most citations from the sciences. Another extension could be to determine the affiliation of the authors. If scientists are contributing to articles in the PoS literature, and vice-versa, that would reveal a type of cooperation between the two fields which cannot be discovered by the current analysis.

I have now demonstrated that PoS articles are cited by scientists to some extent (and more than I expected). Another question is whether philosophers of science *want* to be read by scientists? Several philosophers of science clearly state that philosophers of sci-

[1]Note that the four chosen statistics journals are on the more theoretical side of the statistics spectrum and when I redid the analysis with a more applied journal, *Annals of Applied Statistics*, 44% of the citations came from outside statistics and related fields.

ence should cooperate with scientists, and thus implicitly indicate that they want their work to be relevant to the practitioners of science. Gale (1984) lament as mentioned the growing isolation of philosophy from the sciences, and lays the principal blame for this isolation on the growth of positivism in the nineteenth century. He seems however optimistic for the future, and hopes for closer relationships between philosophers and scientists as PoS changes orientation from "the formal and logical towards the empirical and historical". He desires a discussion about the role of PoS and cites Giere (1984) in that PoS might be better considered an "empirical and scientific activity" in itself rather than a branch of philosophy. Whether Gale's hopes from 1984 have been fulfilled is doubtful; the relationship between scientists and philosophers deteriorated further during the so-called "Science Wars" in the nineteen-nineties, where several scientists like for example the aforementioned Weinberg, sharply criticised philosophy. Hull (2000) blames the isolation of PoS principally on the deliberate professionalisation of PoS, where the scientists and all other non-professional philosophers were excluded from contributing to the field by the philosophers of science themselves. He advocates the creation of a new discipline, Science Studies, which should integrate history, philosophy and sociology of science and were the scientists *must* be included. A more recent example comes from *Tainted: How Philosophy of Science Can Expose Bad Science* by Shrader-Frechette which aims at demonstrating how PoS "can and should make a difference" to science (Alexandrova, 2015). Shrader-Frechette claims that "science often requires understanding philosophy of science" and advocates a "practical" PoS which improves science by " illustrating and assessing methodological flaws" (Shrader-Frechette, 2014).

Other philosophers of science advocate a more segregated view; while emphasizing that PoS *has* made contributions to science, they stress that it is wrong of scientists to expect PoS to directly help advance science (Pigliucci, 2008). PoS should be considered an independent discipline; complementary to the sciences. Chang (1999) claims that modern science is, and needs to be, dogmatic in that "some elements of knowledge must be taken for granted, since they have to be used as foundations or tools for studying other things". Thus certain issues are not investigated in the sciences and these issues are the ones PoS needs to tackle. In fact, Chang wants philosophers of science to "increase scientific knowledge", but by working on questions that are not addressed in the regular sciences. Philosophers should for the most part leave science alone and practice PoS alongside it (Chang, 1999). Pigliucci (2008) holds a somewhat similar view. While he states that both science and PoS can benefit from cooperation, he claims that the two fields have "largely distinct spheres of influence" and that scientists can "safely ignore" some of the issues philosophers of science deal with. However, both authors claim that when it comes

to science teaching and the understanding of science by Society, scientists must turn to PoS.

From Table 1 it is clear that citations of *Studies in History and Philosophy of Science Part B* and *Part C* represent a large portion of the citations of PoS articles in science journals. These journals are examples of Philosophy of X (PoX), where X is a specific scientific field, here Physics and Biology respectively. The different PoXs are generally considered as sub-fields within PoS. PoXs have stronger ties to "their" respective sciences than general PoS; there are for example numerous papers co-authored by biologists and philosophers of biology (Hull, 2000). Some authors claim that PoS has recently turned towards issues more relevant to actual science, and has become increasingly specialised (Richardson, 2012). While some of the aforementioned authors probably welcome this development, others worry that PoS has been marginalised within the philosophy departments, especially in the USA (Richardson, 2012). Philosophers of science are more interested in science and less in other branches of philosophy, like metaphysics and epistemology, and thus the status of PoS within philosophy is decreasing (Richardson, 2012). There has been animated discussions on PoS blogs [2] about this issue and the perceived decline of general PoS in relation to PoX.

In fact, there seems to be little agreement among philosophers of science concerning what the role and central aims of PoS should be (Chang, 1999). Some, like Gale (1984) and Hull (2000), advocate that the field should leave philosophy behind, and construct new disciplines like Theory of Science (Gale) and Science Studies (Hull). Others want to keep PoS within philosophy and continue addressing the classical issues of general PoS, like for example confirmation and reduction. This is not merely an interesting debate, but has an impact on the perception of PoS and probably on the future of the field within academia. Currently, PoS is both considered to be "unpure" philosophy by other philosophers (Doolittle, 2015), while at the same time being considered irrelevant by many scientists. The characterisation of PoS by Krauss is exaggerated, some scientists seem in fact to be interested in PoS as I have demonstrated, but if PoS wants to better its status and increase its impact, philosophers of science need to engage in a discussion on what the role of PoS should be.

[2]The blogs are *New APPS: Art, Politics, Philosophy, Science* and *It's Only A Theory*. Some of the active contributors in these discussions were Mohan Matthen, Eric Schliesser, Gabriele Contessa and Massimo Pigliucci.

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