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CITATION ANALYSIS IN THE CONTEXT OF NOBELISTICS: CITEDNESS FIGURES (An essay of a bibliometrician)

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0. Backgrounds and objectives

Some attempts are known to find a positive correlation between the level of citedness of an individual scientist and his/her official recognition by a society including e.g. membership in the National Academy of Sciences of the USA; correlation are also being searched for between the Nobel Prize distribution and the citedness level of their winners, citedness figures of physicist& chemists, physiologists or specialists in medicine and the probability of awarding them Nobel Prizes (good examples are given in [1, p.92]). Moreover, there are works by Eugene Garfield on calculation of the so-called «Nobel class level» of citedness, i.e. of that «quota» of citations received by an author that «should» make his/her chance to be awarded the Nobel Prize more evident.

Though the most famous author of such a research is Eugene Garfield, the person, whose contribution in the development of citation analysis approach is probably the greatest one, if we proceed with a certain rigorism from enjoying such studies to considering their practical applicability, we should face the necessity to give certain answers to such concrete question as:

1. Are citation studies really helpful enough for pointing out the candidates for awarding them Nobel Prizes?

2. Are there any causal relations between such a property of research of an individual scientist that predetermines awarding the Nobel Prize to this person or serves a prerequisite for it and his/her citedness level?

3. What are the actual relations between the mentioned substances, if any?

If the answer to (2) is «yes», so the answer to (1) is «yes», too. But if the answer to (2) is «no», so for answering question (1) serious considerations concerning question (3) are required. Moreover, in order to answer questions (2) and (3), we are to be sure first in the answer to one more question that seems to be a very simple one to a lot of my colleagues, viz. «What do citations really reflect?»

Should we have a recognizer knowledge of what citedness figures really mean (instead of plentiful myths about their meaning and applicability), we could apply this knowledge to the subject of our discussion in a more sufficient way. But the really scrupulous analysis of the existing concepts of the nature, essence and applicability of citation studies, including the *ab ovo* reconstruction of some trivial notions, is really required for discovering the final answer to the question «What do citations really reflect?».

1. The heart of the problem

A good common-sense answer is, that, as any index used in social studies, citation figures may reflect a lot of latent variables depending on the concept of a researcher [7, p. 17]; any index of science-related phenomena is connected in a probabilistic (stochastic) way with a lot of substances to be assessed (the so-called latent variables) [1, p. 16-20]. E.g., despite the absence of a recognized definition of the «impact» (in the context of studies of science) and treating by some specialists the notions of «impact» and «quality» (of cited papers) as synonyms, a lot of citation analysis experts believe that citedness figures reflects «impact» or «quality» of cited documents. (This viewpoint is perfectly summarized, - I don't mean that it is shared - in Ref. [2] Some other specialists associate the citedness figures with «importance» [3], «value» [4, p. 41], «pertinence» [4, p. 40-43] etc. Of cited materials. Reviewing the various viewpoints, *Haitum* notes also such properties of cited documents associated with a level of citedness as eminence, usefulness etc. [1, p. 92-93]. In the book by *Haitum* [1] the correlations between the distribution of citedness level and publication productivity of cited authors as well as between citedness level of authors and prestige of their affiliations are mentioned [1, p. 91-92]. The estimated correlations between the level of citedness and educational backgrounds of cited authors [5], number of co-authors [6] etc. are also known.

Of course, citedness figures might and can be associated with some of or all the mentioned substances. And it may be true that the citedness figures are among the possible indicators of the «Nobel class» of individual researchers. So, in the question «What do citations really reflect?» we ought to substitute «real» by «best adequately». It occurs that the point is which substance is connected with a certain index in the most adequate way, i.e. which substance is reflected by the index *par excellence*. Once we have adopted the notion of «criterion» as the notion

of the reasonably selected indicator for the best adequate assessment [7, p. 19-21], the problem under discussion is being formulated as 'what is the substance for which the sitedness figures are not just one of the possible indices, but the criterion?'. Only in the context of the answer to this question (*) any speculations on and observations of the «Nobel class level» of citedness could find a correct applicability.

In search for an answer to this question experts practice or recommend to practice various comparative empirical studies [1, p. 16-20 etc.]. However, the known practice of such studies is not so helpful in bringing a correct answer, so the speculative way out seems to be promising. (**)

The proper substance that is reflected citedness figures though indirectly, but *par excellence* (hence: the most adequately), is the substance that is reflected by these figures as a result of causal relations between them. We are also to bear in that some phenomenon exists that is reflected by citedness figures immediately, while such properties of cited documents, like, say, «quality» could be assessed only through the mediation of the phenomenon that is immediately reflected, the latter serving as an intermedium. So, it is necessary to find out the proper and the only subject that is immediately reflected and the corresponding property of cited documents that does have causal relations with it. Only for such a property assessment the citation figures would be the criterion.

The above is a touchstone for the below speculations.

2. Citedness level is not the criterion of a «Nobel class» of a cited author

First, we are to admit that there are some formal evidences that the practice of citedness level calculations must bear no relation to the practice of the Nobel Prizes awarding. Indeed, according to the Founder's will, the Nobel Prizes ought to be awarded «to those who, *during the preceding year*, shall have conferred the greatest *benefit* on mankind» (cited according to [8], italicized by me – V.L.), but in the works devoted to calculations of the «Nobel class level» of citedness, all the citations to all the publications are taken into account, but not the ones for «the preceding year» and devoted to some selected subject. And though, of course, it is very much possible to arrange a study of citedness of only the preceding year publications, it is commonly known that the peak of the level would never been reached during such a short while.

The mentioned discrepancies are, of course, just nothing but technical obstacles. «Preceding year» studies could be arranged, while the maximum and average «quotas» of citedness for a short period of time could also be calculated as for physics, chemistry, physiology or medicine as for their selected subareas. (However, it is also possible that in a lot of cases we would have no citations at all for this short while, and such «quotas» could also occur to be senseless because of the small size of a sampling.) Another technical problem is that, in contrast to

what was quoted above, the «preceding year» rule of awarding is practically executed very seldom; however, the various «quotas» of citedness regarding different periods of time and related factors could be principally developed. So, the above formal evidences do not actually mean anything.

The real problem is how citedness relates to the «benefit on mankind» in general.

First of all, as well as one needs no demonstration to contend that citedness level does not immediately reflect of a «Nobel class level» of a cited scientist, nobody pretends to proclaim that citedness is an index (not saying a word of being the criterion) of the «benefit on mankind». However, we are to try to compare the notion of citedness with the possible constituencies of the «benefit on mankind» to have a more reasoned answer.

According to the dictionary definition, the «benefit» in general is an «advantage; profit; anything contributing to an improvement in condition» [9, p. 172]. But, again, citedness level was hardly ever been associated with the notions of «advantage» and «profit»; however, the notion of «contributing» is semantically close to the notion of «impact», which, in its turn, is one of the most frequent terms for indication a substance reflected by citedness level.

The relevant ideas of what «impact» is (in the context of science studies) are the following: «impact» is «influence or effect» [10, p. 451] and «a forcible momentary touch, contact or impression» [9, p. 910] (***). But once we have agreed that «impact» of cited documents (or their authors) is their influence, effect or impression on the citing persons, we are to agree with some of argumentations of *Kara-Murza* [11] (whose aim was to refute the option that the analysis of the citedness figures could be an adequate index of «impact» on science (***)), viz.:

– «...if a certain work is cited in a lot of articles... this fact demonstrates... the mass character of the market of consumption of a cited work. Such data... are very important, but is it really possible to express the impact on science, the impulse that is given to its development by a certain work, through the mass character of its consumption?» [11, p. 70-71];

– «it is possible not to cite an idea, but it's impossible not to cite a method» [11, p.71]. This comment refers to some findings that methodic papers receive more citations than conceptual ones. The author of [11] implies that the impact of ideas on science development is not less than those of methods;

– «amending of existing methods... arises a larger level of citedness than the creation of original methods» [11, p.72]; a number of supporting examples are given; the author implies that the impact of original methods is obviously greater, while the figures of citedness level of the papers describing the original methods may be lower;

– «not all the communication that are necessary for the work reach an author of this work» [11, p. 73]. It is implied that the citedness level of some paper with a

great im-pact on science in general can be smaller than its real impact if a certain paper occur-red to be behind some of the «information barriers» for a substantial part of researchers.

However, most of the quoted comments are just a listing of demerits, while the presence of demerits by itself does not mean that some index could not be the criterion.

What is really important in the paper [11] (which is, according to my competence, the only one that expresses the direct disagreement with the opinion that citedness is a good index of an «impact»), is the attempt to point out the phenomenon immediately reflected by citedness, that is followed by some effort to demonstrate that «impact» is not a substance that really corresponds to this phenomenon. As *Kara-Murza* formulates, this phenomenon is «consumption» of cited documents [11, p. 70-71].

However, to demonstrate the absence of correspondence of «impact» to the «con-sumption», one must also point out such a property of cited documents that totally corresponds to «consumption». Also, one must be sure that «consumption» is really the phenomenon that is sought for. This is the subject of the next chapter, while, as for the present one, the outlined speculations are more than enough to conclude that citedness level is neither the criterion of a «Nobel class» of a cited author nor of his/hers «benefit on mankind». Its applicability as an index, though being doubtful as it followed from the above analysis, is still a subject of the further speculations plotted in Chap. 5.

3. Citedness level immediately reflects *use* of the cited scientific documents

In general – we have agree in the previous chapter that plentiful exceptions are quite meaningless by themselves – citedness level documentary confirms the actual use of cited scientific documents that has already taken place during the fulfillment of a relevant creative work by the authors of citing papers: in general, first, a document is read; then – if it was not thrown away as evidently useless – it is being considered; then – it may be used (for comparison, including disproving; assimilation of the methods described etc... etc...); then, – if it is used during the fulfillment of a relevant creative work, – it is cited in the papers describing some of its results (according to the scientific ethics of the author, editorial policy of the publishers etc.).

It does sound absolutely obvious and I am sorry for reminding of such trivial things. But I was again compelled to speculate in such a manner, reconstructing some trivial notions just *ab ovo*: having looked through my collection of photocopies in search for a good reference to be cited instead of the previous passage, I came across almost literally just a couple of papers whose authors did not hesitate that use is the phenomenon of cited documents that is immediately reflected by citedness level (e.g. [12; 13]). The possibly best example of the

paradox that the above obvious idea is not recognized so much as it ought to be in the above-cited paper [11] where the citedness is associated with the «consumption» (i.e. with use) as the immediately reflected phenomenon [11, p. 70-71], but, at the same time, the same status is given to the association of citedness with «connections in science», and with «high appreciation of [cited scientific production]» [11, p. 69]. It is not entirely understandable from [11] if the appreciation is treated as the reason of use or as another phenomenon reflected by citedness equally with use. At the same time, in far much more number of articles the phenomenon that is sought for is described in such an abstract manner like e.g. «connection of a certain [citing] paper with the preceding [cited] ones» [1, p. 89], and there is a number of papers which authors treat use and citedness as substances absolutely independent from each other (e.g. [14; 15; 23] etc.).

Once we have agreed that the use of cited documents is the phenomenon immanently reflected by citedness, it is simple to cognize what is the property of cited documents that is indirectly reflected *par excellence*, i.e. what is the property for which the citedness level is the criterion.

4. Citedness figures indirectly but *adequately* reflect the *value* of cited scientific documents

Among the variety of terms used for indication of the property reflected by citedness level («quality», «pertinence», «usefulness», «topicality» etc.) there is the only one that is causally associated with the notion of the use, viz. «value».

In philosophy the notion of «value» is treated as the criterion of preference in the situation of alternative choice [16, p. 111] (a concrete reference is chosen to be cited), while as for scientific literature, the notion of value is treated also as its ability to facilitate reaching the target of the researchers activity [16, p. 111] (i.e. to accomplish a study described in a citing paper). More important, however, is the fact that in the Information Science there is a notion of the value of information which is defined as the «property of information, determined by its fitness for practical use in various spheres of human activity for the achievement of a certain aim» [17, p. 464] (italicized by me – V.L.). The value of information is described through the notion of use, and we have all the right to expand this conclusion to a single document or to an organized collection of the documents: «outside a scientific document the human society does not possess the scientific information, too, since it is namely a document that is a material form of its fixing» [18, p. 102]. Then, it is hardly possible at all to obtain any confirmed characteristics of the value of some object without the experience of its use because the value of an object is determined «not only by its internal structure *per se*, but also by the fact that an object is involved in the sphere of social human genesis» [19]. It is known that the most outstanding scientists failed in experimental evaluation of the value of various scientific works before the latter started to be

actually used [18, p. 167]. So, it might be clear, that being an aid of immediate reflection of the actual use of the documents, the count of citedness figures is an aid of an indirect best possible adequate evaluation of the value of cited documents (or, to be a pedant, of their *scientific* value because the value may be aesthetical, historical etc. [20, p. 51].

To exclude any hesitations that value is really the matching property let me analyze a couple of definitions of «quality» which is one of the most frequently used term in bibliometric/scientometric literature associated with cited documents.

According to [21], quality «...is a category that demonstrates the characteristics of the object which is attributed to it only as an object of cognition, therefore the characteristic that exists only relatively, depending on a cognizing subject», while according to [22], «where, for example, two kinds of cloth are said to differ «in quality», it would usually be meant not merely that they differ, but that one kind is better (by appropriate standards) than the other...». That means that quality, being totally dependent on a cognizing subject (like e.g. an expert) [21], seems to have no causal relations with the notion of use. The second quotation demonstrates that quality is being cognized not only irrespective the use, but also with the aid of some ideal standards [22]. As for the Information Science recognized terms, the term «quality» is not in the corresponding dictionaries, and its practiced use in the meaning of «value» is absolutely arbitrary.

The «pertinence» is also not a matching property of cited documents reflected by citedness figures *par excellence*: this term means a «characteristic of the degree of content of documents, found as a result of an information retrieval, to the the information need, expressed in an information demands» [17, p. 308] (italicized by me – V.L.). The analogous lack of correspondence refers to all the names of the properties that I ever saw in association with citedness. So, citedness level is the criterion of the value of cited papers. (In case of necessity kindly look up the note (***) again.)

5. Citedness and «impact»: more and again. Conclusions

The idea that citedness level is the criterion or a good indicator of «impact» was severely criticized in [11]. However, now it's understandable that this conclusion could be apparent only through the analysis of relationships between the notions of «impact» and «value» (as the latter has the causal relations with citedness).

On the level of a common sense one is free to say that citedness reflects an influence or a strong impression of cited documents on citing authors, but such an influence («impact») of a valuable paper is, indeed, just a consequence of a paper's value. And this consequence is not so much obvious, straightforward or compulsory: if a certain researcher frequently cited a certain paper, it is not known or sure if he/she has been strongly influenced by it or he/she is not thinking a lot about it at all, but it is known, that this person uses this document repeatedly. The

opposite situation is even more obvious: one might be strongly impressed by some paper, but, if he or she is not working at the present in the same direction, so he or she would not use it actively, would not cite it... and the «impact» of the document (in the literal sense of the word) would not be reflected. We may conclude, that «impact» could be reflected by citedness, - but in a far much more stochastic manner than value is reflected.

It could be expressed as follows:

- citedness immediately reflects use (the 1st intermedium),
- use is causally connected with value (the 2nd intermedium),
- value is stochastically connected with «impact».

So, there are two intermediums between «impact» as the property of scientific documents (and their authors) to be assessed and their citedness figures as a possible index of this property, the second intermedium (value) having just probabilistic (stochastic) relationships with the subject of such an assessment. That means that citedness is a very poor index of «impact». This contradicts to a lot of myths that have been formed during decades, but once we agreed with this conclusion, we have got an answer to the question (2). («Are there any causal relations between such a property of research of an individual scientist that predetermines awarding the Nobel Prize to this person or serves a prerequisite for it and his/her citedness level?»): even the «impact», which is the only notion that can be conditionally treated as a synonym of «contributing», which, in its turn, can be treated as one of the possible constituencies of «benefit», has no causal relations with the level of citedness. So, it is more obvious that the «benefit of mankind» (that is not described through the notion of value of the scientific documents of a candidate or a winner of the Nobel Prize) has no causal relation with citedness figures, too: one more intermedium presents in this situation. So the possible relations here are not just stochastic, they are «much more stochastic than in case with impact. At the same time, it is agreed to apply the term «index» only to such an assessable intermedium, which connections with the content of later variable to be assessed are at least argued by a distinct hypothesis [30, p. 36].

So, how could we succeed in practicing the use of citedness figures for the «Nobel class level» estimation, if «impact» is even not a full synonym of «contributing», the latter, in its turn, being only one of the possible constituencies of the «benefit» as a defined property of a Nobel class research?

The corresponding estimations therefore, has the meaning almost opposite what was sought for: it is interesting to study the relative value of the works of Nobel Prizes Winners. In a study design it should be emphasized, of course, what is value ('the property of a document, determined by its fitness for practical use in various spheres of human activity for the achievement of a certain aim') and what is benefit. (The special definitions of the «benefit of mankind» that could be used by the Nobel Committees are not the common knowledge; I have no idea if the

exist. Should such definitions been available, a much more concrete answer could be given).

6. Further challenge or introduction to part II. («Assessment of citing scientific documents according to the structure of references *in them*»)

The problem of citation studies is generally two-fold, while the vast majority of the experts pay attention only to the first aspect of it. The much better studied aspect is, of course, the use of citedness level figures for quantitative assessment of a property of cited papers, their authors etc. But the problem of the assessment of citing papers according to the quantitative data on the structure of references in them also exists, while the publications in this subarea are very few. In the context of Nobelistics this problem is of an apparent interest even because it is both promising and exiting to investigate the «citation behavior» (the term is coined in [25]) of the most famous and recognized scientists of the world and the «cognitive basis» (this term is coined in [26]) of their research.

Reconstructing the problem of a property, reflected in such studies *ab ovo* I am to tell that the potential value of a scientific document that is just being created (so, neither yet being used nor being addressed to, but having already references to the documents used while it was being created) is predetermined by the conditions of its creation [16, p. 113], while, possibly, the most important ones are the information conditions. They are called «cognitive basis» [26, p. 16] of a research, which is reflected in the structure of the references in a *citing* paper [26, p. 16]. Thus, if we «decipher» this structure, we can assess the potential value of *citing* papers (that might enable one to have the most rapid, almost immediate assessment).

However, such assessment is too much rough, because:

1) the stochastic nature of such assessment is far more stronger than in case with cited papers;

2) therefore, such an approach is absolutely useless when applied to a single paper or to small amounts of them and might be good only for the sufficient collections of papers;

3) in contrast with the assessment of cited papers, where a more number of citations normally stands for their better value, in this case it is required to find out various indicators of structure of references, to determine their meaning and to estimate the «standard» magnitudes for comparison.

The problem of «deciphering» the references structure in *citing* documents for the assessment of their potential value is still a great challenge [27; 28]. And the problem of the «standard magnitudes» is only meeting some very first approaches that just seem reasonable [29]. However, the point is it the Nobel Prizes Winners works could be reasonably used as a source of references for developing the «standard magnitudes» and what is the meaning of such a «standard». All these substances are the subject of a special paper in preparation,

and I am pleased to announce that I am intended to publish it in the *IN/ Proceedings*.

Endnotes:

(*) This question is not very far from being original, but, unfortunately, the one that is frequently forgotten by a number of citation analysis experts; therefore I was compelled to remind some of the common knowledge in such a detailed manner.

(**) The usual practice is to postulate that one of the methods or indices under comparison is a «control» one and then to interpret the differences in the obtained results as the invalidity of the other index or method. E.g. in [23] the differences in the figures of interlibrary loan borrowing of periodicals and periodicals citedness figures were explained as an «invalidity» of citedness approach, while these differences were just a consequence of the differences in indices, which revealed themselves «qualitatively» through the fact that when a document to be potentially used may be requested once and then it may as well be cited as many times as in many papers being created it was actually used, i.e. once, a few times, a lot of times, never. We might say in this case that the initial postulate was a «false [i.e. not reasonably selected] criterion».

Another typical example is [24], where two different properties of a document were, as a matter of fact, under study, but the authors of the empirical study did not realize it and compared the results as if they were heterogeneous, though obtained with the aid of different methods.

In general, the problem of criteria selection can be solved neither by postulating nor by empirical studies: the quantitative assessment of the development of science makes one principally possible to determine only the correlations between the distributions of the magnitudes of various indices with each other, but not the graphs of the alterations of the magnitudes of indices with latent variables [31, p. 32]. Speculations, therefore, are the only way out.

(***) It does not concern the «impact-factor», which is just a technical term for a technical indicator.

(****) The author of [11] himself gives no definition of impact.

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ЗА КУЛИСАМИ НОБЕЛЕВСКИХ ПРЕМИЙ ПО ФИЗИКЕ И ХИМИИ¹

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Первые Нобелевские премии были вручены в 1901 г.: по физике - немецкому ученому Вильгельму Конраду Рентгену (1845-1923) за открытие излучения, носящего его имя; по химии - выдающемуся голландскому физико-химику Якобу Хенрику вант Хоффу (1852-1911); по медицине - немецкому

¹ Статья представлена автором на польском языке; перевод с сокращений В.М.Тютюнника.