On the opportunities and limitations of the H-index[1]

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Abstract. A new indicator for the assessment of the research performance of individual scientists was suggested by Jorge E. Hirsch in 2005. Several opportunities and limitations of this new measure are discussed.

The traditional bibliometric indicator toolset is based on simple statistical functions including means, relative frequencies and quantiles. Nonetheless, these publication- and citation-based statistics proved to be robust and useful output measures of activity and performance of scientific research. Above all, normalised indicators have substantiated their strength in comparative studies at the meso and macro level. In contrast, the evaluation at the micro level, above all, the assessment of the research performance of individual scientists remained most problematic. The reason is twofold, on one hand, a sufficiently large publication output produced in a relatively short time span is necessary to obtain statistically reliable indicators and research productivity and citation impact are not necessarily correlated variables, on the other hand. That means, if these statistical methods can be applied a set of different cases has still to be examined, namely how low/high publication activity relates to low/high citation impact. In order to overcome these shortcomings bibliometricians are faced with in micro-level studies, Jorge E. Hirsch (2005) has recently suggested a new indicator for the assessment of the research performance of individual scientists. This measure – called *h-index* – is designed for application at the micro level, and measures of both publication activity and citation impact. According to the definition by Jorge E. Hirsch, a scientist has index h if h is the largest number of his/her N papers having received at least h citations each.

Hirsch's idea has immediately found interest in the public (Ball, 2005), and received positive reception both in the physics community (Diniz Batista et al., 2005, Popov, 2005) and the scientometrics literature (Bornmann and Daniel, 2005, Braun et al., 2005). The latter two papers have shown that the h-index correlates with other bibliometric indicators of 'significance'. This could be confirmed by van Raan (2005) as well, however he stressed that scientific performance can hardly be expressed simply by one indicator alone.

The advantages of this index are evident. The *h-index* can obviously be applied to any set of papers. Since the *h-index* cannot exceed the umber of underlying papers, we can even define $h = 0$ for completely inactive authors. In what follows we briefly summarise the most important features of the *h-index* some of which can already be found in the original paper by Hirsch.

- The *h-index* is an extremely simple and comprehensible composite indicator which can be applied to any level of aggregation but favorably to the assessment of research performance of individual scientists.

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- This indicator combines citation impact with publication activity measures.
- The *h-index* is a robust cumulative indicator. Increasing publications alone does not have immediate effect on this index.
- The *h-index* measures “durable” performance, not only single peaks.
- Any document type can be included since the *h-index* is not changed by adding uncited papers.
- The *h-index* correlates with other bibliometric indicators of ‘significance’.

These advantages are contrasted by several shortcomings which will be summarised below.

- The *h-index* puts newcomers at a disadvantage since both publication output and observed citation rates will be relatively low.
- The index allows scientists to rest on their laurels (‘*your papers do the job for you’*) since the number of citation received might increase even if no new papers are published.
- This indicator is based on rather long-term observations. Therefore, it does not show decay in a scientist’s carrier by the same reason as above.
- The index is not independent of subject-specific communication behaviour and cannot be normalised in a similar manner as other publication- or citation-based indicators.
- An important problem arises in finding appropriate reference standards for comparison even in the same subject field.
- The indicator is suited for the micro level but at higher levels of aggregation there are more versatile indicators. The application of appropriate indicators sets instead of one single measure can provide a more adequate and multi-faceted picture of reality.
- By definition, the *h-index* cannot exceed the number of publications. Thus it puts small but highly-cited paper sets at a disadvantage (‘*small is not beautiful*’).
- According to my experience, the *h-index* is certainly useful for identifying outstanding performance but it seems to fail in assessing fair and good performance. The reason can be found in the skewed rank-frequency distributions which are characterized by extremely long tails with many ties (Glänzel and Persson, 2005, Glänzel, 2006).

Summarising these *pros* and *cons* we can conclude that the *h-index* is certainly an interesting indicator the strength of which lies in the potential application to the assessement of small paper sets were other, traditional bibliometric indicators often fail or at least were their application proved usually problematic. The fact that the list of the *cons* somewhat exceeds that of the *pros*, does not necessarily mean that the disadvantages predominate. It just means that problems might arise in several applications. The *h-index* is a cumulative indicator that does take neither the dynamics of publication activity nor the ageing of citation impact into account and that crashes the multidimensional space of bibliometrics into one single dimension. Both theoretical work on the mathematical-statistical background and systematic research in the application of this measure is necessary to reveal more perspectives and/or further limitations. Nonetheless, I am convinced that the *h-index* is a useful

supplementary indicator, enrichment for the bibliometric toolset, but it is certainly not suited to substitute advanced indicators which have long ago become standard in bibliometric work.

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