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Cross-field evaluation of publications of research institutes using their contributions to the fields' MVPs determined by *h*-index

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ABSTRACT

We propose a cross-field evaluation method for the publications of research institutes. With this approach, we first determine a set of the *most visible publications* (MVPs) for each field from the publications of all assessed institutes according to the field's *h*-index. Then, we measure an institute's production in each field by its percentage share (i.e., *contribution*) to the field's MVPs. Finally, we obtain an institute's cross-field production measure as the average of its contributions to all fields. The proposed approach is proven empirically to be reasonable, intuitive to understand, and uniformly applicable to various sets of institutes and fields of different publication and citation patterns. The field and cross-field production measures obtained by the proposed approach not only allow linear ranking of institutes, but also reveal the degree of their production difference.

1. Introduction

The *h*-index (Hirsch, 2005), originally designed as a characterization of a researcher's publication output or research performance, has its application quickly extended to institutional evaluation, which was suggested by Hirsch himself in the original paper.

Along one branch of study for such extension, institutes are considered as a higher-level aggregation of researchers. Prathap (2006) proposed a two-level approach: a level-one *h*-index (h_1) which is the original *h*-index obtained from the publications from an institute, and a level-two *h*-index (h_2) supplementing the h_1 index which specifies that there are h_2 researchers in the institute, and each has an individual *h*-index at least h_2. Schubert (2007) proposed an approach called *successive h-indices* applicable to a hierarchy of aggregations in a bottom-up manner. According to Schubert, given the *h*-indices of the researchers of an institute, an index of the institute is determined exactly by the same method as what Prathap proposed.

Along another branch of study of applying the *h*-index to institutes, the original *h*-index is modified by taking into consideration the sizes of their publication sets. Molinari and Molinari (2008a, 2008b) decomposed the original *h*-index of an institute into the product of an impact index h_m and a factor related to the number of publications from the institute. By factoring the latter out of the *h*-index, the impact index h_m is considered as a characterization of an institute's "intrinsic

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visibility" and then used to compare institutes. Since h_m requires that the number of publications ranges above a few hundreds, Sypsa and Hatzakis (2009) further modified h_m by another factor and claimed that their modified h_m can be applied to institutes with large as well as small publication sets.

Even though these studies focused on institutes and some indeed applied the h-index and the above adaptations to interdisciplinary or cross-field institutional evaluation (cf. Arencibia-Jorge, Barrios-Almaguer, Fernández-Hernández, & Carvajal-Espino, 2008; Arencibia-Jorge & Rousseau, 2009), we notice that most applications were limited to specific programs (Pires Da Luz et al., 2008), departments (Lazaridis, 2010), facilities (Grothkopf & Stevens-Rayburn, 2007), research groups (Van Raan, 2006), or fields (Mugnaini, Packer, & Meneghini, 2008; Rousseau, Yang, & Yue, 2010; Sypsa & Hatzakis, 2009) of the assessed institutes.

Kinney (2007) pointed out the reason when he applied the impact index h_m to measure the federally funded science centers and institutes in the fields of physical sciences, engineering, and technology. Kinney specifically excluded the field biomedicine as he claimed that "the publications of many of the top ranked institutions are dominated by bio-medical research, which dwarfs the other scientific disciplines."

In other words, an institute's expertise usually spans across a number of different fields, subject areas, or disciplines (hereafter, *fields*), and these fields are of different bibliometric features (Vinkler, 2010b). Some fields (e.g., biomedicine) have a large number of publications with quickly accumulated citations whereas others (e.g., social science) have a limited set of publications with significantly fewer citations. We believe that, without taking such field-dependent publication and citation features into consideration, an approach to cross-field evaluation of publications of research institutes may very possibly deliver distorted result.

The cross-field evaluation of publications of research institutes has already been targeted by quite a number of authors. The most notable ones in recent years are the various variants to the crown indicator developed by the Centre for Science and Technology Studies (CWTS) at Leiden University. The crown indicator (Moed, De Bruin, & Van Leeuwen, 1995) is calculated by dividing the average number of received citations for aggregated publications from a specific unit with the average number that could be expected for publications of the same document type (e.g., articles, reviews, letters, etc.), from the same analyzed time span, published in journals within the same field. One variant to the crown indicator by Lundberg (2007) is based on an alternative normalization scheme where the normalization is carried out on the level of individual publication, rather than on aggregated levels as the crown indicator does. Empirical analysis and theoretical comparison to the two normalization schemes can be found by Waltman, Van Eck, Van Leeuwen, Visser, & Van Raan (2010, 2011). Another interesting improvement is the I3 indicator by Leydesdorff and Bornmann (2011).

As to the h-index, its being a citation-based indicator has made it susceptible to the field dependency issue as well. We can see this from a simplified example. An institute i has h-indices n_{if} and n_{ik} for its publications in two fields f and k (hereafter, the institute i's field h-indices), respectively, and an h-index n_i when the publications of both fields f and k are combined together (hereafter, the institute i's cross-field h-index). Clearly, $n_i \geq n_{if}$ and $n_i \geq n_{ik}$. Then, when we combine the publications of both fields together and determine the cross-field h-index n_i, we can ignore those field-f publications having citations less than n_{if} (and therefore n_i) and those field-k publications having citations less than n_{ik} (and therefore n_i). However, if the field f is a many-publication-high-citation field and the field k is a few-publication-low-citation field, n_{if} is usually greater than n_{ik}. Then n_{if} actually sets a high bar and those field-k publications having citations less than n_{if} can also be ignored. We as such would expect that the cross-field h-index n_i reflects more of the institute i's production in the many-publication-high-citation field f. In the worst case where all publications in the field k have citations less than n_{if}, we would have $n_i = n_{if}$ and the institute i's production in the few-publication-low-citation field k is completely dismissed by its production in the many-publication-high-citation field f.

Now, if another institute j has superior production in the many-publication-high-citation field f but inferior production in the few-publication-low-citation field k compared to the institute i (i.e., $n_{jf} > n_{if}$ but $n_{jk} < n_{ik}$), it does not seem fair to jump to conclusion that the institute j outperforms the institute i simply because $n_j > n_i$ when the institute i's better production in the few-publication-low-citation field k is largely, if not all, ignored.

Just like the crown indicator and other related cross-field measures, there are studies adapting the h-index for cross-field comparison using various normalization schemes. However, these studies have limited themselves to researchers specializing in different fields.

Batista, Campiteli, Kinouchi, and Martinez (2006) proposed to divide the h-index n of a researcher by the average number of authors in the considered n papers. Iglesias and Pecharromán (2007) suggested dividing the h-index of a researcher by the average number of citations per paper of the researcher's respective field. Valentinuzzi, Laciar, and Atrio (2007) proposed two indices claimed to be discipline independent with the whole spectrum of published and cited papers taken into consideration. Radicchi, Fortunato, and Castellano (2008) rescaled a researcher's publications and citations by dividing them with the average numbers of publications and citations per paper in the field, respectively. Then, a "generalized h-index" is obtained using the rescaled numbers.

Our greatest concern over these approaches, be it crown-indicator-like or h-index-based, is that they all require a thorough treatment or analysis for the publications from all institutes in a field in order to obtain the field's correction or normalization parameters (e.g., the size factor for the h_m index or the average numbers of publications and citations for rescaling), even though we are assessing only a limited set of institutes. Some of the approaches also have limitations such as the impact index h_m's requiring that the number of publications of the assessed institutes has to be large enough.