A confusing definition of disruption

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Abstract It is important to measure whether a work is disruptive or developing. In 2016, Funk and Owen-Smith proposed novel indexes to evaluate the degree of a patent consolidating or destabilizing the technology streams (doi:10.1287/mnsc.2015.2366). Based on their methods, Wu et al. (2019) studied the disruption of articles, patents and software products, and made a conclusion that small teams are more disruptive than large teams (doi:10.1287/mnsc.2015.2366). Our research finds that the effect of N_R on the disruption equation is contradictory as the sign of the disruption changes, and this problem may cause more trouble in any further work based on their indexes. When using other suitable approaches to measure how disruptive a work would be to the field of science or technology, we predict that there is no significant difference between large and small teams.

Keywords Innovation Measurement, Disruptive Work, Developing Work, Disruption, Citation Analysis, Research Evaluation, Metrics, Indicators

Introduction

It is important to measure whether a work is disruptive or developing. Wu *et al.*¹ used an index that was previously designed by Funk and Owen-Smith² to measure how disruptive a work would be to the field of science or technology. A flaw in this disruption measure raises concerns about the validity of their conclusions.

The definition of disruption

As Wu *et al.*¹ reported, Equation (1) shows the definition of the disruption:

$$D = \frac{N_F - N_B}{N_F + N_B + N_R} \quad (1)$$

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where D is the disruption of the focal work, N_F is the total number of works that cite just the focal work without citing any of the work's references, N_B is the total number of works that cite both the focal work and any its references, and N_R is the total number of works that cite just any of the focal work's references without citing the focal work itself (Fig. 1).

Fig. 1 Illustration of elements in citation networks

Examples

The first two lines of Fig. 1 indicate that a nonzero N_R weakens the disruption of the focal work when the value of $(N_F - N_B)$ is positive. For example, by comparing works α and β in Table 1, we can see that β has a larger N_R and ends up being judged less disruptive. This assessment fits the common sense that a larger N_R should lead to a less disruptive work if the values of N_F and N_B are fixed.

Table 1 A demonstration of measuring disruption as defined by Equation (1)

Focal work	N_F	N_B	N_R	Disruption
α	90	10	0	0.80
β	90	10	100	0.40
γ	10	90	0	-0.80
δ	10	90	100	-0.40

Things become complicated when the value of $(N_F - N_B)$ is negative. By Equation (1), the existence of N_R enhances the disruption of the focal work when the value of $(N_F - N_B)$ is negative. By comparing works γ and δ in Table 1, we can see that, both β and δ have a large N_R value. Accordingly, we may expect δ to be less disruptive than γ , just like β is less disruptive than α . However, if we apply the disruption measure reported by Wu *et al.*¹, we find that δ is more disruptive than γ , since δ has a larger disruption ($-0.40 > -0.80$).

Such a confusing result implies that the given disruption measure cannot reveal the true disruption of a scientific or technological work in some cases. Therefore, in Wu *et al.*'s work¹, any conclusion based on regressions fitting the relation between team size and disruption may be unreliable. Moreover, views disagreeing with Wu *et al.* have been reported by some previous research efforts which showed that individuals working alone are less likely to make breakthroughs and more likely to end up with ordinary outcomes³, while larger teams tend to achieve higher-impact and more destabilizing results^{2,4}.

Conclusion

In conclusion, the effect of N_R on the disruption is contradictory as the sign of the disruption changes, and this problem may cause more trouble in any further work based on Equation (1). The authors consider it as a flaw in this disruption measure, and strongly recommend Wu *et al.* to redesign this approach or come up with a reasonable explanation for the inconsistency. When using other suitable approaches to measure how disruptive a work would be to the field of science or technology, the authors predict that there is no significant difference between large and small teams.

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