

# Auditing Citation Polarization During COVID-19 Pandemic

*Keywords: COVID-19-related publication, citation dynamics, journal impact factor, rich-get-richer effect, polarization*

## Extended Abstract

The recent pandemic boosted scientists to invest in COVID-19-related research, which introduced enormous academic publications. In 2021, more than 4% of all publications are determined to be COVID-19-related works [1]. These publications received a number of citations in a short period according to their attention to the pandemic, and it significantly increased the impact factor (IF) of journals. This reemerged the IF controversy, which concerns the inaccurate reflection of scientific impact [2,3], misunderstanding of the quality of an individual paper [4], and the misuse of research evaluation and malpractices [5,6]. Resolving this IF controversy requires a comprehensive understanding of citation dynamics in academia [7-9], such as the extent to how much COVID-19-related papers change journal IF and who benefits more.

In this study, we analyzed the academic changes of journal IF caused by COVID-19-related publications, with publication data from Web of Science Core Collections and COVID-19-related papers with search queries provided by Dimensions. The significant amount of COVID-19-related papers and their high number of citations in a short period exhibit increased attention in academia. A heavier-tailed citation distribution also shows that citation dynamics of COVID-19-related papers were exceptional from others. However, most of their citations came from other COVID-19-related papers. The homophily of citations, i.e., the high rate of citation exchange, indicates that the rising amount of COVID-19-related research resulted in a high number of citations (Fig. 1A).

These highly cited papers inflated the publishing journals' IF. To quantify the surplus IF, we calculated journal IF including and excluding COVID-19-related papers, with document types based on the Journal Citation Reports. We first found that 84% of journals that published one or more COVID-19-related papers increased their IFs. The increased amount of IF is proportional to the prior IF (Fig. 1B), instead of the number of COVID-19-related papers (Fig. 1C). The contribution of a single paper to increase IF decreased with the number of COVID-19-related papers increased. This implies that citations on COVID-19-related papers are unequally distributed, which provides more chance to be cited with publication in high IF journals [8]. In addition, from the high correlation between IFs in 2020 and 2021 excluding COVID-19-related papers, we can conclude that IF inflation is temporal.

The surplus IF is concentrated in high-ranked journals. Comparing the surplus IF with the ranking of journals in terms of IF, high-ranked journals increased their IFs more in both absolute and relative surplus. This trend is robust across all research categories. However, we found that the surplus IF does not change the academic landscape. The journal ranking in their categories was not changed. Only 20.0% of journals moved to a higher quantile. The highly-cited COVID-19-related papers are distributed in high-ranked journals and at the beginning of the pandemic (Fig. 1D,E). While the top 10% ranked journals published 26.3% of all COVID-19-related papers, 84% of papers with over 1000 citations were published. Only 3.5%

of papers were published in 90% to 100% ranked journals, and no papers with over 1000 citations were published in the bottom 50% journals. The highly-cited COVID-19-related papers were generally published earlier.

As a result of this rich-get-richer effect of citations, the increased IF caused by COVID-19-related papers worsened the inequality of research fields in terms of IF. The surplus IF increased the Gini coefficient (Fig. 1F), even though the ranking of journals did not change. Gini coefficient in each research category increased when they published COVID-19-related papers. In conclusion, we uncovered the citation dynamics that may have led to a more severe polarization of journals. COVID-19-related papers increased IF, but the surplus was distributed more to high-ranked journals. The prestigious journals received more attention from the public, and their publications got more citations even though some publications were eventually retracted [10]. The surplus IFs do not change the ranking of journals, and this led to the increasing inequality of journals in the same field. Our findings of vulnerability and inequality of journal IF support the San Francisco Declaration of Research Assessment (DORA) that warns against the use of journal-based measures as a proxy for the quality of individual research papers.

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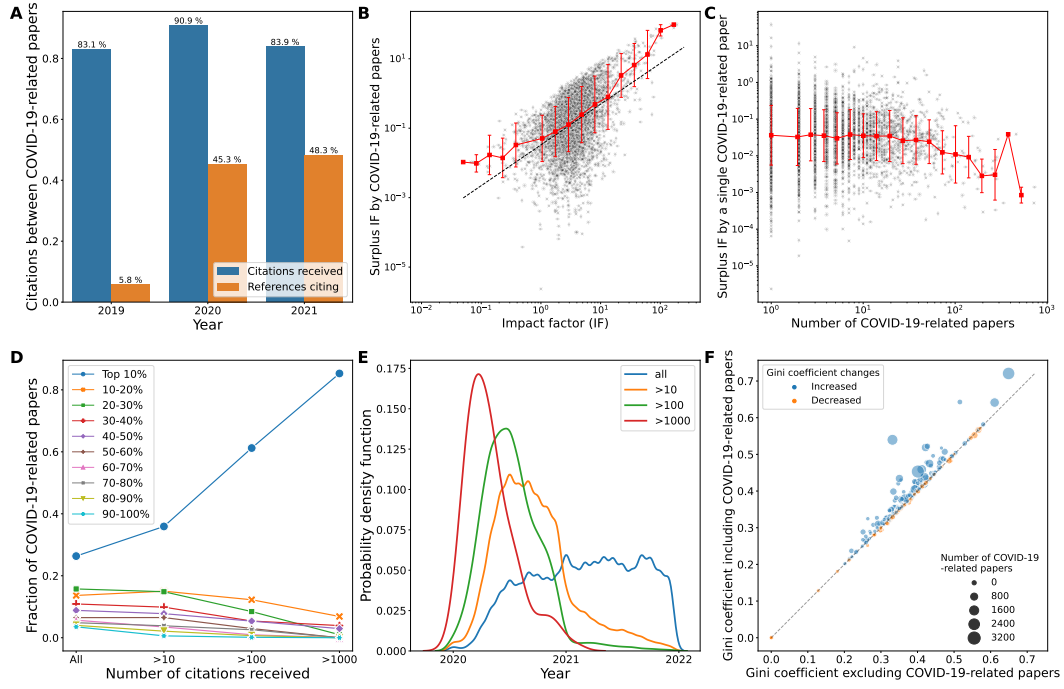


Figure 1: **A** Citation origin of COVID-19-related papers. **B** Journal impact factor increase by publishing COVID-19-related papers, where the simple superlinear growth  $y \sim x^{1.7}$  can characterize the growth pattern (dotted line). **C** Increase in IF per COVID-19-related paper in proportion to the number of COVID-19-related papers published in journals. In both B and C, the red dots represent the average value of surplus IF and the error bars show the standard deviation in log-scale. **D** Distribution of COVID-19-related research by journal ranking. **E** Distribution of COVID-19-related papers by publication date. **F** Plot of the Gini coefficient of the IF distribution by JCR category and the number of COVID-19-related papers.