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# Is the immediacy index of co-authored papers higher than that of single-authored ones?

## *O índice de imediatez de artigos em coautoria é maior do que o de um único autor?*

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### Abstract

The study extends the conversation on the effect that co-authorship has on the citation impact of papers by analyzing the short-term advantage of co-authored papers. The results suggest that co-authored papers have a higher short-term impact than single-authored ones in all scientific domains. The study adds insights on the use of the immediacy index as an alternative indicator to evaluate the short-term competitive advantage of co-authored papers concerning the number of citations they attract. Furthermore, the study shows the efficacy of the immediacy index in comparing the short-term impact of different groups.

**Keywords:** Citation analysis. Collaboration. Co-authorship. Immediacy index. Multi-authorship.

### Resumo

*O estudo estende a conversa sobre o efeito que a coautoria tem no impacto da citação de artigos, analisando a vantagem de curto prazo de artigos em coautoria. Os resultados sugerem que artigos em coautoria têm maior impacto em curto prazo do que artigos em autoria única em todos os domínios científicos. O estudo adiciona insights sobre o uso do índice de imediatismo como um indicador alternativo para avaliar a vantagem competitiva de curto prazo de artigos em coautoria quanto ao número de citações que eles atraem. Além disso, o estudo mostra a eficácia do índice de imediatismo para comparar o impacto de curto prazo de diferentes grupos.*

**Palavras-chave:** Análise de citações. Colaboração. Coautoria. Índice de imediatez. multiautoria.

### Introduction

Since Beaver and Rosen (1978, 1979a, 1979b) introduced the subject-matter of academic collaboration into the academic conversation among Scientometrics scholars, interest in this topic has continued to grow. One of the core questions to be answered has been the effect of collaborative activities on the number of citations that papers receive. The knowledge produced in this line of research has grown significantly and has become the most attractive topic for collaborative researchers, mainly in the Scientometrics scientific community.

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There is a great deal of studies analyzing the possible influence that academic collaboration, via co-authorships, has on the citation performance of papers (Katz; Hicks, 1997; Katz; Martin, 1997; Glänzel, 2000, 2002; Glänzel; Schubert, 2001, 2005; Rousseau; Ding, 2016). In general, the results show that there is a lack of consensus to either support or reject the hypothesis that co-authorship is indeed a driver to increase the number of citations that papers receive.

The relationship between co-authorship patterns and citation impact has been explored using different approaches in a diverse number of research fields. *i.e.*, information science (Levitt; Thelwall, 2016), informetrics (Abrizah *et al.*, 2014), computer science (Ibáñez; Bielza; Larrañaga, 2012), Finance (Avkiran, 2012), strategic management (Ronda-Pupo; Guerras-Martín, 2010), and Economics (Levitt; Thelwall, 2010). Those previous studies mainly analyzed the medium or long-term effect of co-authorship on citation impact. The literature lacks studies on the short-term effect of co-authorship on citation impact.

In recent years, collaboration researchers have shifted their attention to analyzing the effects of internationally collaboration papers on their citation impact (Rousseau; Ding, 2016; Wagner; Whetsell; Leydesdorff, 2017), the relationship between the position of countries in the co-authorship networks and their citation performance (Sadatmoosavi *et al.*, 2018), and international co-authorships among institutions (Gazni; Thelwall, 2016; Ronda-Pupo; Guerras-Martín, 2016), countries (Aman, 2016; Zhang *et al.*, 2016) or regions (Aldieri; Kotsemir; Vinci, 2018). Other studies focused their attention on international collaboration patterns among elites *i.e.*, the collaboration between developed countries (Adams; Gurney, 2018) or among elite scientists (Abramo; D'angelo; Di Costa, 2018). The exploration of the short-term influence of international co-authorships on the citation impact of papers will add insight into this relationship.

In general, the previous studies shed light on the relationship between co-authorships and the citation patterns of papers using different citation-based indicators and different citation thresholds. The literature lacks studies on the short-term effects on citation patterns comparing co-authored papers and single-authored papers. The objective of the study is to analyze the short-term advantage of co-authored papers concerning the number of citations they attract using a large-scale exploration of papers published in the Web of Science database, including journals in all scientific domains in 2012.

The study analyzed 908,827 papers published in 2012 in 430 journals in the Clarivate Analytics' Web of Science Core Collection database. The results are aimed at decision and policy makers, researchers on collaborative strategies, and individual scholars wanting to formulate a collaboration strategy.

## Related work

The immediacy index measures the percentage of articles that receive citations in the very first year they are published. Previous studies using the immediacy index as a citation-based impact indicator range from 1981 through 2016. The literature on this subject-matter is split into two main lines of research. The first deals with the analysis of journals and their impact factor (Asai, 1981; Tomer, 1986; Magri; Solari, 1996; Richmond, 2004; Yue; Wilson; Rousseau, 2004; Menezes; Mohankumar, 2006; Wan *et al.*, 2010; Huang; Lin, 2012).

The second line of research deals with the use of the immediacy index to detect hot topics within a single field of research (Buriak, 2015), the evaluation of the short-term impact of individual fields as Molecular Psychiatry (Licinio, 1998, 2006), Environmental Science (Grassian, 2016), Materials Chemistry (Buriak, 2015), and advanced synthesis & catalysis (Richmond, 2004).

The previous studies show the efficacy of the immediacy index for detecting journals or topics that capture the attention of the scientific community in the very first instant they appear. The present study, unlike previous

ones, uses the immediacy index to compare the short-term citation impact according to co-authorship patterns of papers in all scientific domains. The hypothesis to be tested is:

*Co-authored papers will show a higher Immediacy Index than single-authored papers.*

## Methodological Procedures

### The data

The data for the study consists of 908,827 papers (articles, reviews, notes, and letters) published in 2012 in 430 journals in the Clarivate Analytics' Web of Science Core Collection database.

### Organization of the data

The Science Metrix journal classification ontology was used to assign each paper to a single and mutually exclusive scientific domain (Archambault; Beausnesne; Caruso, 2015). For consideration of the advantages and technical background of the Science Metrix ontology, see Ronda-Pupo and Katz (2017).

### Variables

#### Dependent variable

The Immediacy Index: Is the average number of times an article is cited in the year it is published (Minnick, 2017). The Immediacy Index is used mainly to measure the impact at the level of journals. It is calculated by dividing the number of citations to articles published in a given year by the number of articles published in that year. Below is an example of the expression for calculating the immediacy index of co-authored papers in 2018.

*Immediacy Index (Co-authored)*

$$= \frac{\text{(Citations to Co-authored papers published in 2018)}}{\text{(Number of Co-authored papers published in 2018)}}$$

#### Independent variable

Co-authored paper: a paper that is signed by more than one author. The number of co-authored papers in a domain is the total of co-authored papers published in journals of that domain.

Single-authored paper: a paper published by a solo author. The number of single-authored papers in a domain is the total of solo papers published in journals of that domain.

### Statistical procedures

The "Mann-Whitney Rank Sum Test" nonparametric was used to test for statistically significant differences in ranks between the two groups (Single-authored vs. Co-authored) and the Immediacy Index. This was chosen because citation counts do not meet the assumption of normal distribution for a parametric statistical test. To check for the robustness of the results we use the effect size suggested by Cohen (1988). Cohen's (1988) suggestion needs

the value of the correlation  $r$ . As the Mann-Whitney U nonparametric test does not provide the  $r$  value in the output to measure effect size, it was calculated using the Morgan *et al.* (2013) conversion formula  $\frac{r=z}{\sqrt{N}}$ .

## Results

Table 1 presents the number of papers in each domain according to their authorship patterns. More than one author signs 91% of the papers. Co-authored papers account for 95% of citations.

Table 2 shows that the percentage of papers that receive citations in the year they were published is notably higher in co-authored papers than in single-authored ones in all domains. Only 5% of solo papers received citations in the year they were published. The domain with the highest difference is Multidisciplinary. There is a smaller gap between cited/non-cited papers in the Economic & Social Sciences and Health Sciences domains.

Table 3 shows the length of the distributions according to authorship patterns. Except for the Arts & Humanities and Economic & Social Sciences domains, multi-authored papers have lengthier distributions than single-authored papers. The Natural Sciences and Health Sciences domains have lengthier distributions.

**Table 1** – The number of papers and citations of domains in 2012.

Domain	n°		Citations to		n°		Citations to	
	Single-authored	%	Single-authored	%	Co-authored	%	Co-authored	%
Applied Sciences	13,007	7	3,822	4	186,077	93	89,220	96
Arts & Humanities	10,432	73	1,001	50	3,839	27	1,016	50
Economic & Social Sciences	15,410	37	2,981	31	26,787	63	6,645	69
Multidisciplinary	1,462	16	335	2	7,880	84	14,024	98
Health Sciences	15,847	5	8,225	4	326,656	95	220,219	96
Natural Sciences	24,836	8	10,028	5	276,594	92	174,897	95
Overall	80,994	9	26,392	5	827,833	91	506,021	95

**Table 2** – Percentages of papers cited in 2012.

Domain	% Single-authored papers cited	% Co-authored papers cited
Applied Sciences	16	25
Arts & Humanities	6	16
Economic & Social Sciences	13	17
Multidisciplinary	14	47
Health Sciences	26	31
Natural Sciences	20	29
Overall	14	27

**Table 3** – Length of distribution.

Domain	Distribution Length Single-authored	Distribution Length Co-authored	Difference
Applied Sciences	25	45	20
Arts & Humanities	14	13	-1
Economic & Social Sciences	12	14	2
Multidisciplinary	11	47	36
Health Sciences	26	74	48
Natural Sciences	32	82	50

## The immediacy index

The results presented in Table 4 suggest that the short-term citation impact of Co-authored papers, measured using the immediacy index, is higher than for single-authored ones in all domains. Multidisciplinary co-authored papers show a greater difference. Multidisciplinary includes the most influential journals such as Science, Nature, Proceedings of the National Academy of Sciences of the United States of America (PNAS), PLOS, and Frontiers, among others. The Economic & Social Sciences domains show the smallest difference. In general, it is known that social sciences domains attract a smaller number of citations than natural, applied, and health sciences.

**Table 4** – The Immediacy Index of 2012 papers for domains according to authorship patterns.

Domain	Co-authored	Single-authored	Difference
Multidisciplinary	1.78	0.23	1.55
Health Sciences	0.67	0.52	0.15
Natural Sciences	0.63	0.40	0.23
Applied Sciences	0.48	0.29	0.19
Arts & Humanities	0.26	0.10	0.16
Economic & Social Sciences	0.25	0.19	0.06
<b>Overall</b>	<b>0.56</b>	<b>0.26</b>	<b>0.30</b>

## Hypothesis test

The nonparametric *Mann-Whitney Rank Sum* to test for statistically significant differences in ranks between the two groups (Single-authored vs. Co-authored) and the Immediacy Index was run because the normal distribution of the dependent variable was not met  $P=0.005$ , and the variances are unequal  $Levene=2.008, p=0.05$ . The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (**Mann-Whitney U Statistic= 9.00,  $p < 0.05$** ). Co-authored articles have higher ranks (0.610) than single-authored articles (0.290) on the immediacy index  $U= 37.00, p= 0.048, r= 0.52$ , a “larger than typical” effect according to Cohen (1988) guidelines. As the *Mann-Whitney U* nonparametric test does not provide the  $r$  value in the output to measure effect size, it was calculated using the Morgan *et al.* (2013) conversion formula  $r = \frac{z}{\sqrt{N}}$ . The values of  $z$  and  $N$  are provided in the *U* Test Statistic table.

According to the results, the hypothesis is supported, and it is concluded that co-authored papers have a short-term competitive advantage over single-authored ones. Co-authored papers capture the attention of scientific communities faster than single-authored papers.

The multiplicative effect of the social capital of the paper’s authors is a competitive advantage that enhances the impact of the manuscript. It represents a driver to enhance the citation impact because co-authored papers have a higher probability of being noticed. For example, if five authors publish a paper, they will let their network of colleagues know about their paper, while solo-authored papers only have the social network of a single author. The process of dissemination of co-authored papers is more effective than for single-authored papers.

## Discussion and Conclusion

The present study examined the short-term influence of co-authorship on the citation impact of papers for all domains. The results support the hypothesis that co-authorship represents a competitive advantage that

enhances the number of citations that papers will receive in the year they are published. There are no prior results in the literature reporting on the correlation between the immediacy index and co-authorship. In general, no consensus has been reached about the relationship between scientific collaboration and citation count (Shen *et al.*, 2021). The result of the study supports the prior results that report that papers published by more than one author receive a greater number of citations (Katz; Hicks, 1997; Shen *et al.*, 2021). This study adds a competitive advantage for co-authored papers, which attract a greater number of citations in the short-term – the year in which they are published – than papers that are published by a single author.

The practical implication of this result is twofold. Firstly, it supports the collaboration strategy for enhancing the citation impact of papers. Specifically, they obtain a greater number of citations in the short-term. Secondly, it shows the efficacy of the immediacy index as a measure of the short-term impact of papers at the level of domains. Furthermore, it is a useful tool for making comparisons between two groups.

The research opens new research questions such as: how does the immediacy index of co-authored papers compare to that of single-authored ones at the level of sub-fields? Can the immediacy index be used to compare the short-term impact at different levels of aggregations i.e., departments, institutions, countries, and regions? Also, for the comparison of the short-term impact of international and domestic co-authorships.

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