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SPECIALIZATION AND MULTIDISCIPLINARITY: WHAT KIND OF TALENTS DO WE NEED?

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Abstract

Countries are trying to improve their position by strengthening the segments of science, research and innovation. Attracting talents is focused on experts from various disciplines. The importance of multidisciplinary research is often mentioned in the focus of research. Although this is a significant segment of research with relatively highly cited results, our paper shows that specialization plays – in some sense - even more important role in the current achievements of science. Therefore, the acquisition of talents must be targeted not only in terms of profile and economic potential of host country/city, but also on their specialization. Analyzing a set of data related to publications and quotes shows that, compared to 21 specialized disciplines, multidisciplinary research is the least published in top magazines and thus the least cited. Using about 14.3 million Web of Science (WoS) documents, 142.9 thousand highly cited documents, and 171.5 million citations, we found that, although the number of citations per paper for multidisciplinary research papers is similar as in specialized research papers (in multidisciplinary category citations/paper is 14.5, average for all disciplines is 12.3), the number of WoS papers as well as the number of highly cited papers in this group of scientific papers are the lowest. This fact suggests that in top research there is a greater chance of succeeding in specialized research than in multidisciplinary one.

Key words

specialization, multidisciplinarity, talents, scientific papers, citations

JEL classification

A10, I23, O30, O31, 034, J61

1. Introduction

Specialization and multidisciplinarity (often used in research is similar term interdisciplinarity we use interchangeably both terms here) are two components that intermingle in some research activity. Countries are trying to improve their position by strengthening the research fields of science, research and innovation. Gaining talents is focused on experts from various disciplines. The importance of multidisciplinarity is often mentioned in the focus of research. Although multidisciplinary research is a significant research field with relatively cited results, our paper shows that narrow specialization plays an even more important role in the current achievements of science. Therefore, the acquisition of talented people (talents) must be targeted in terms of their specialization, country economic and science profiling and economic potential.

2. Focus at the difference between specialization and multidisciplinarity

There are numerous papers focused on the topic of multidisciplinarity/interdisciplinarity. Interdisciplinarity, in a similar view as we use multidisciplinarity, is analyzed in Sanz-Menéndez et al (2001) in three different research areas: pharmacology and pharmacy, cardiovascular system and materials science, using data from a survey to Spanish scientists. The study focuses on three complementary dimensions: (1) diversity in personal training and research specialization of scientists; (2) research practices and behavior of the groups; and (3) the cognitive inputs and outputs of the research activity. Interdisciplinarity emerges as a double-edged process: of engaging into a new area with people of different research fields, in coherence with the traditional disciplinary research teams; and of specialization in a field traditionally dominated by a single group of disciplinary backgrounds, in which researchers from different research fields join the teams. Thus specialization-fragmentation-hybridization all come together (Sanz-Menéndez, Bordons and Zulueta, 2001).

Interdisciplinary scientific research challenges the study of science on a number of fronts, including creating output science indicators. Wagner et al (2011) literature review began with a narrow search for quantitative measures of the output of interdisciplinary research that could contribute to indicators, but the authors expanded the scope of the review as it became clear that differing definitions, assessment tools, evaluation processes, and measures all shed light on different aspects of interdisciplinary research. Existing output measures alone cannot adequately capture this process. Among the quantitative measures considered, bibliometrics (co-authorships, co-inventors, collaborations, references, citations and co-citations) are the most developed, but leave considerable gaps in understanding of the social dynamics that lead to knowledge integration. Emerging measures in network dynamics (particularly centrality and diversity) are promising as indicators, but their use requires sophisticated interpretations. Combinations of quantitative measures and qualitative assessments being applied within evaluation studies appear to reveal interdisciplinary scientific research processes but carry certain burdens (for example expense). Wagner et al´ s (2011) review is a first step toward providing a more complex view of measuring interdisciplinary research.

The paper of Porter, Roessner and Heberger (2008) presents results produced by a team charged with evaluating a program to facilitate interdisciplinary research in the United States. The team has developed and tested promising quantitative measures of the integration and specialization of research outputs, the former essential to evaluating the impact of the program. Both measures are based on Thomson-ISI Web of Knowledge subject categories. Integration measures the cognitive distance among the subject categories of journals cited in a body of research. Specialization measures the spread of subject categories in which a body of research is published. Pilot results for samples from researchers drawn from 22 diverse subject categories show what appears to be a high level of interdisciplinarity.

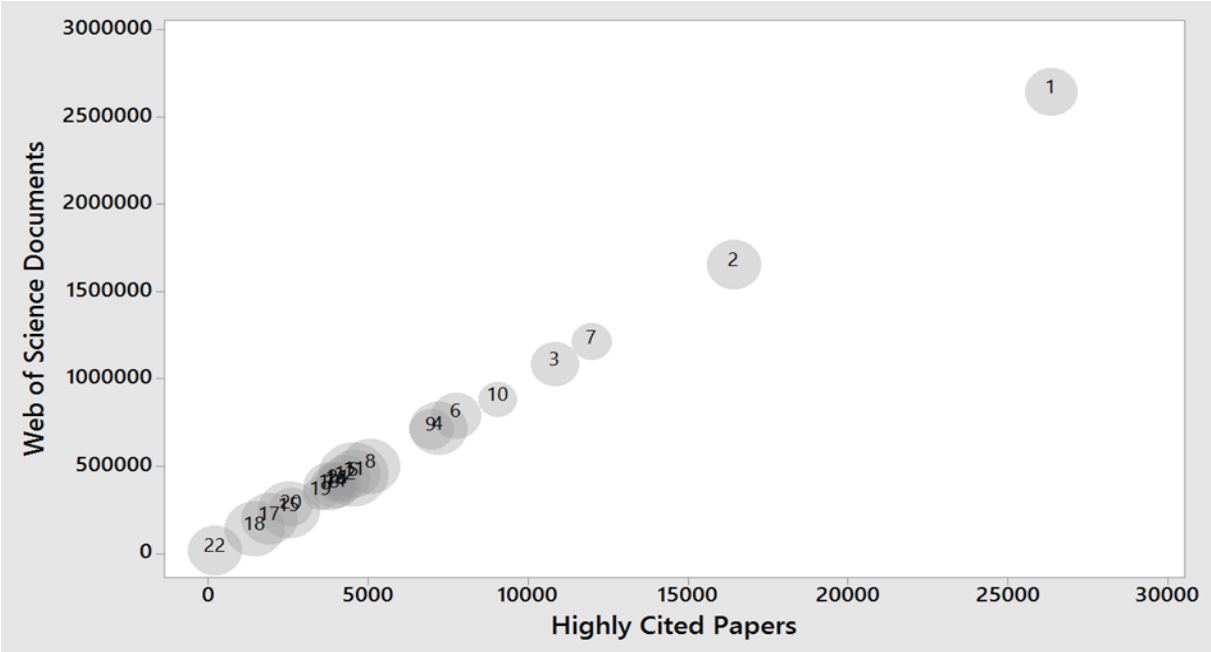
In the last two decades there have been studies claiming that science is becoming ever more interdisciplinary. However, the evidence has been anecdotal or partial. Porter and Rafols (2009) investigated how the degree of interdisciplinarity has changed between 1975 and 2005 over six research domains. They compute bibliometric indicators alongside a new index of interdisciplinarity (integration score) and a science mapping visualization method. The results attest to notable changes in research practices over this 30 year period, namely major increases in number of cited disciplines and references per article (both show about 50 percent growth), and co-authors per article (about 75% growth). However, the new index of interdisciplinarity only shows a modest increase (mostly around five percent growth). Science

maps hint that this is because the distribution of citations of an article remains mainly within neighboring disciplinary areas. These findings suggest that science is indeed becoming more interdisciplinary, but in small steps — drawing mainly from neighboring fields and only modestly increasing the connections to distant cognitive areas (Porter and Rafols, 2009).

A number of sociological and scientometric studies already concluded that scientists working in the interdisciplinary fields of nano-and biotechnology still remain strongly grounded in their referent disciplines (see Rafols, 2007).

Analyzing a set of data (ESI database covering period January 2008 to April 2018) related to publications and citations in 22 research fields, we show that compared to 21 specialized research fields, the multidisciplinary research field is the least top-notch. In total, there are 22 research field groups, one group of which is a multidisciplinary research field group. Others belong to different fields of natural and social sciences as well as to human sciences. We analyzed 14.3 million Web of Science (WoS) documents, 142.9 thousand highly cited documents, and 171.5 million citations. We found that although the quoted multidisciplinary documents are similar to multidisciplinary research as in specialized research (multidisciplinary citations per paper = 14.5, average for all disciplines = 12.3), the number of papers in WOS and the number of highly cited papers, this group of scientific articles is the lowest. This fact indicates that there is a greater chance of excellence in specialized research than in multidisciplinary research. Figure 1 shows the position of individual research fields.

Figure 1: Position of individual research fields (Total research fields N = 22)



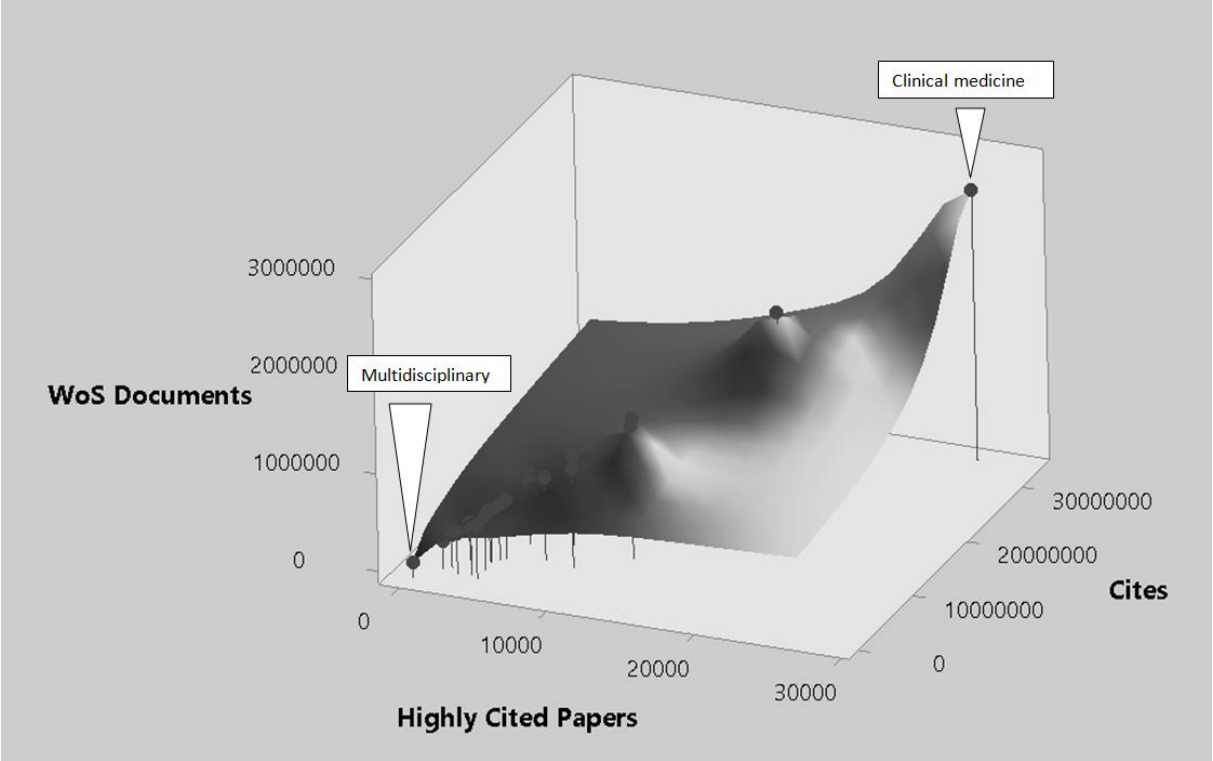
Source: Own computations.

Note: Figures in bubbles represent individual research fields - (1) clinical medicine; (2) chemistry; (3) physics; (4) biology and biochemistry; (5) molecular biology and genetics; (6) material science; (7) engineering; (8) neuroscience and behavior; (9) plant and animal science; (10) social sciences, general; (11) environment/ecology; (12) geosciences; (13) pharmacology and toxicology; (14) psychiatry/psychology; (15) immunology; (16) agricultural sciences; (17) microbiology; (18) space science; (19) computer science; (20) economics and business; (21) mathematics; (22) multidisciplinary.

Figure 2 shows a surface view of the above-mentioned differences. The clinical medicine research field is the area of research with the largest number of published WoS documents (2.6 million), the highest number of citations (33, 2 million) and 26.4 thousand highly cited papers.

Multidisciplinary sciences show significantly lower values (20.6 thousand documents, approximately 300 thousand citations and only 201 highly cited papers). The only similarity in both research fields is an average number of citations per paper, which is 12.6 for clinical medicine category, and 14.5 for multidisciplinary science category.

Figure 2: Surface plot of “WOS documents” vs “Citations” vs “Highly cited papers”



Source: Own computations.

3. Implications for talent acquisition

From the results we can conclude, with a certain degree of reserve, that in order to increase the competitiveness of a country/city, it is necessary to emphasize the increasing specialization of experts. International teams are usually formed by the integration of highly specialized experts who are identified by their publications and citations in specialized journals. Specialized publications provide a sufficient space to identify talents and quantify their contribution to science. Not always, however, purely quantitative parameters are a guarantee of success, as the relationship between publishing activity and valuation of results, for example, with the Nobel Prize, suggests. In any case, the set of talented people is quite precisely specified by quantitative evaluation.

If a country or a city wishes to have a significant position in the world of science and research, or in the technologically advanced segments of production, it must create centers in which talented people are concentrated. Often these centers are created at major universities.

The development of such centers then increases their significance as these centers begin to cross the boundaries of universities and they are starting to expand.

4. Conclusion

The paper sought to indicate that in situations where countries seek to increase their scientific research potential and evaluate the parameters of their research capacities, there are areas that are more prominent than others. A comparison of 22 research fields has suggested that the comparatively weakest results in terms of citations and publications in the WoS and in top journals are in the multidisciplinary research field. The values of publications in this field of research are much lower than the values of all the remaining research fields. The most cited work is in the field of molecular biology and genetics (23.2 citations per article).

When orienting future research in small economies, in addition to aspects such as the economic financing of research (for example, the pharmaceutical industry is requiring enormous volume of financing for investment), the tradition of research fields, or competition in a given research field, one should also take into account also the level of specialization. It seems that even specialization may be a more viable way of success in scientific research than focusing on the multidisciplinarity in science. Indeed, multidisciplinarity may be, in some ways, very demanding in regard to coordination of different research fields. In addition, it may be one of those research fields that have been so far inadequate enough in their detailed and/or complex results. For detailed consideration, however, it would be necessary to analyze in more detail individual research results, particularly in the field of multidisciplinary sciences. This may be the subject of further research.

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