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Multi-authorship and its impact on the visibility of research from Puerto Rico

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ABSTRACT

The impact of the existence and nature of multi-authorship on the visibility of research results is a relevant issue in the framework of the monitoring and evaluation of scientific performance. Multi-authorship involving researchers from different institutions is a growing trend typical of today's social, economic and political development and an expression of the so-called "internationalization of science". This paper analyzes how the establishment of scientific relationships and the local or international nature of such relationships affect the visibility of the research results published by the community of researchers affiliated with Puerto Rican institutions. Multi-dimensional indicators and multivariate analysis techniques, specifically Factorial Correspondence Analysis (FCA), were used to analyze and represent the visibility of the papers published in mainstream scientific journals. The results of the study show that the establishment and furtherance of local and international co-authorship favour the visibility of the papers published and consequently can be regarded to be a valid strategy in the context of the research and development effort in Puerto Rico.

1. Introduction

The study of the impact of multi-authorship and the local or international nature of such partnering on the visibility of published research results is justified inasmuch as greater visibility guarantees that the new knowledge generated by scientific activity is suitably and effectively circulated among the scientific community at large.

The furtherance of multi-authorship and the preference for publishing in journals included in scientific citation indices have been observed as part of a strategy for enhancing the visibility of a country's, institution's or scientific team's research results (Van Raan, 1997, 1998). Moreover, partnering among researchers is considered to be a characteristic development in today's science, in keeping with its internationalization (Larivière, Lebel, & Lemelin, 2004; Liu, 2003).

Some studies have shown that the disciplines characterized by high rates of international co-authorship have higher citation levels and greater impact among the scientific community (Frederiksen, 2004) than those where such cooperation is less relevant similarly, the existence of international collaboration tends to enlarge the visibility and impact of a country's scientific production (Goldfinch, Dale, & Derouen, 2003; Leta & Chaimovich, 2002).

In the case of Puerto Rico, studies conducted on the characteristics of Science Citation Index (SCI)-listed scientific production over the period 1980–1999 showed that over 60% of the papers generated involved multi-authorship, and 75% of these were authored internationally (Suarez Balseiro, Sanz Casado, & Ortiz Rivera, 2006).

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Such behaviour is typical of small scientific communities, such as in the case of Puerto Rico, where scientific production is primarily generated in the public higher education system, whose largest and most important institution is the University of Puerto Rico (UPR) (Ortiz Rivera, 2003).

The UPR participates in over 80% of the papers by Puerto Rican authors published in SCI-indexed journals. This research effort contributes substantially to the strengthening of the institution's credibility and prestige. It is likewise important as the basis for ongoing financial and administrative support, as well as the acknowledgement of the university community by society and external agents. In this regard, the university carries on a programme to encourage evaluation culture, one of whose initiatives consists in the monitoring and evaluation of the results that measure the attainment of institutional goals, as well as the maintenance and enhancement of institutional, professional and specialized accreditation.

The purpose of this paper is to analyze how inter-institutional authorship and the local or international nature of such partnering has affected the visibility of the research results published by scientists affiliated with Puerto Rican institutions between 1980 and 1999.

Table 1
Visibility by type of multi-authorship: number of papers[a] (1980–1999).

Visibility	Not multi-institutional	Multi-institutional		
		Local	International	Total (local and international)
Q1	1298	441	1685	2126
Q2	513	154	766	920
Q3	402	136	395	531
Q4	458	281	235	516
Total	2671	1012	3081	4093

[a] Articles, meeting-abstracts, letters.

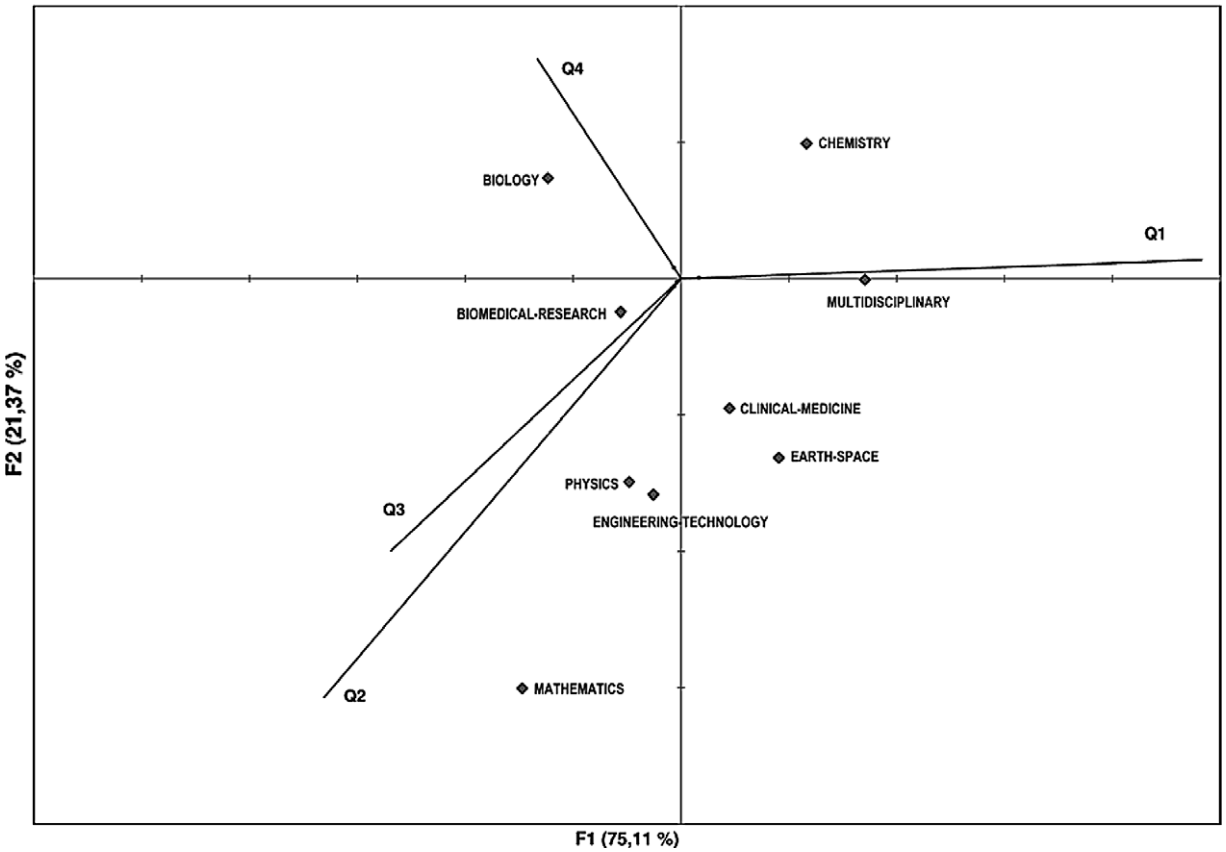

Fig. 1. No multi-authorship (asymmetric FCA).

2. Methodology

The data source used for this paper was the version of the Institute for Scientific Information's Science Citation Index © (SCI) available on the *Web of Science* (Thomson Reuters). Papers having at least one author affiliated with an institution located in Puerto Rico were identified through a search and retrieval strategy using the institutional affiliation field as the criterion for searching the database, which includes the addresses of all the authors of a given paper.

This strategy was designed to identify all the records with at least one field showing institutions located in Puerto Rico, even if they were US federal organizations present on the island. The total number of records after elimination of duplicate data came to 7271. Each record was then assigned a subject area in keeping with the discipline addressed by the journal where the article was published, using for this purpose the Journal Citation Reports/Science Citation Index © (JCR/SCI) classification schedules from 1984, 1987, 1994 and 1997. The classified records were then grouped in nine theme categories: earth and space, biology, clinical medicine, physics, chemistry, biomedical research, engineering-technology, mathematics and multidisciplinary. This grouping adopted the scheme proposed by L'Observatoire des Sciences et des Techniques (OST), with a single difference: the addition of the multidisciplinary category (OST. L'Observatoire des Sciences et des Techniques, 2000).

The data retrieved were processed and analyzed in accordance with the methodology for information metrics studies developed in the papers by Sanz Casado and Sotolongo Aguilar (Sanz Casado, Suárez Balseiro, García Zorita, Martín Moreno, & Lascurain Sánchez, 2002; Sotolongo Aguilar, Suárez Balseiro, & Guzmán Sánchez, 2000). This methodology ensures the control of each step of the process and provides for data transfer to the software used to obtain the multidimensional indicators.

The visibility attained was based on the position of the journal where the paper was published in the respective subject area, according to the JCR© classification. This criterion, likewise used by other authors, divides the JCR© subject areas into quartiles, with journals listed in decreasing order of the value of their impact factor and visibility therefore declining from the first to the fourth quartile (Bordons & Barrigón, 1992; Pouris, 2005).

The effect of the existence and type of multi-authorship on research visibility was studied using simple factorial correspondence analysis (FCA), which is a graphic method for analyzing data (Greenacre, 1993). This methodology is similar to the approach adopted by García Zorita (2000) to study the scientific production of Spanish economists, based on papers by Nagpaul and Sharma (1995) and Bhattacharya (1997), where supplementary points were used to compare such researchers' preferences for subject areas when publishing in domestic or international sources.

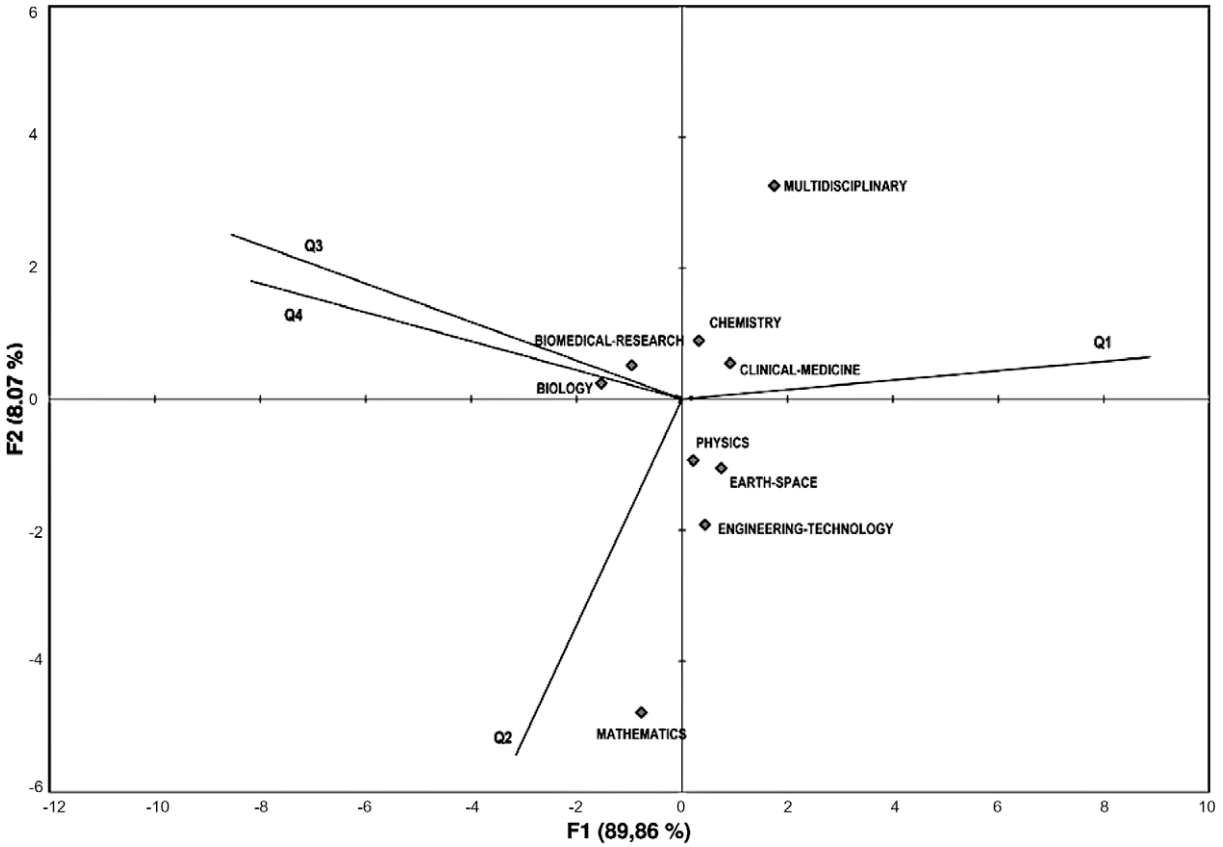

Fig. 2. Multi-authorship (asymmetric FCA).

FCA can represent large quantities of data, generally in two- or three-dimensional space. The data adopt the form of contingency tables that show, in rows and columns, the co-occurrence of the various levels of two qualitative variables as absolute frequencies. In some cases the contingency table may contain additional columns or rows called supplementary points. Generally speaking FCA is based on the transformation of the differences between the vectors formed by two row- or two column-levels of a contingency table into distances that can be used to extract the factors – dimensions – that would best explain the original data set. The distance used is χ^2, computed from the so-called *row and column profiles*. A *profile* is a vector resulting from dividing the components of each row – or each column – by their respective totals; in addition, each profile is assigned a mass vector – by rows and columns – that is computed by dividing the entire row, or column, by the table total. A simple transformation of the row profile table, consisting in dividing each cell in a row by the square root of its mass, yields the distance between the row points used in graphic representations. A similar process is applied to the column profiles. If the row and column points are plotted as principal coordinates – positions of profiles with respect to a principal axis – the result is a *symmetric* map. On *asymmetric* maps, on the contrary, the points are represented as different coordinates, so the column points may be plotted as principal coordinates and the row points as standard coordinates – positions of vertices with respect to a principal axis – (Greenacre, 1993). With symmetric maps the clouds of row and column points generated – strictly speaking – in different spaces can be compared (Greenacre, 1993). The utility of asymmetric maps, in turn, lies in the possibility of conducting row point analysis of a profile with respect to the points themselves as well as to the vertex points of the other profile.

The analyses conducted here (with XLSTAT® software, module CA) were carried out with the data on frequency of publication in each of the nine subject areas in which the papers were classified: first, the points referring to papers involving multi-institutional authorship were regarded to belong to the FCA and the ones without such partnering to be *supplementary* data. In the second analysis, papers where multi-authorship was international were regarded to belong to the FCA and the articles with local multi-authorship to be *supplementary*. The column data taken to be supplementary points were plotted in the space housing the rest of the row and column – or active – points. While their position may be interpreted in relation to the latter points, they make no contribution to total table variance or *inertia*.

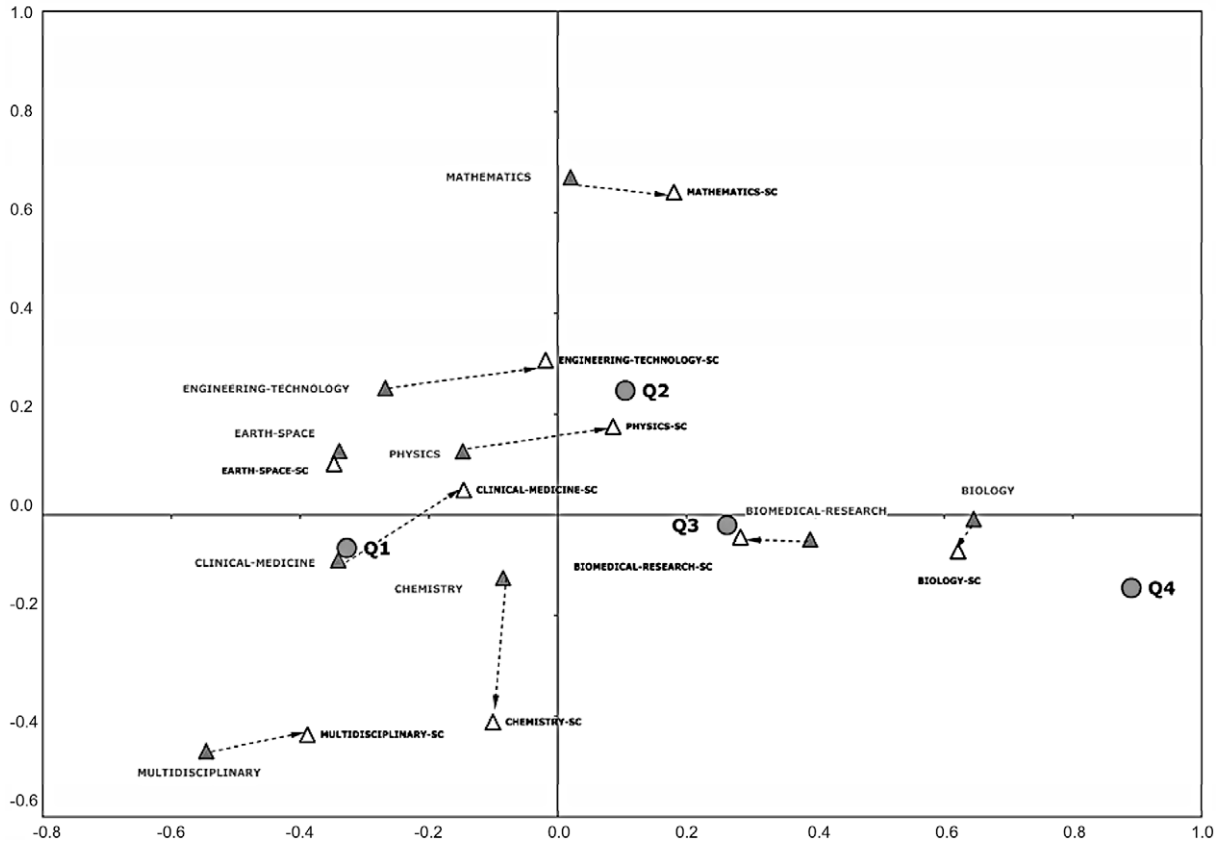

Fig. 3. Position of the nine theme categories in visibility space, with and without multi-authorship (FCA with supplementary rows) (▲) with multi-authorship (Δ) without multi-authorship.

3. Results

Table 1 gives the distribution of the publications authored by Puerto Rican researchers by quartile and type of multi-authorship. According to these data, the largest number of papers was published in first quartile journals, with multi-authored research accounting for 62.1% of the total in this quartile; 79.3% of such papers involved international multi-authorship.

Fig. 1 shows the asymmetric map of the theme category profiles of non-inter-institutional papers in relation to the vertices defining visibility space. This figure shows the difference in the position of the vertex associated with the first (Q1) and all the other quartiles. And among the latter, the horizontal axis defines a distinction between the position of the fourth (Q4), corresponding to the least visible papers, and the other two quartiles, Q2 and Q3, which are closer to one another. The position of the chemistry paper profile, whose projection is closer to vertex Q1 because many of the papers are published in this quartile, also indicates that a substantial portion of this production is published in fourth quartile journals (Q4). The position of biology is found in Q4, Q3 and Q2 quartile space, revealing similar rates of publication in journals with those levels of visibility. The non-multi-authored papers on clinical medicine and earth–space exhibit publication tendencies closer to the first two quartiles (Q1 and Q2).

The following figures show the results of a visibility analysis of multi-authored papers as well, in Fig. 3, as a comparison of individually authored papers. Fig. 2 shows a greater distance between the papers published in the first (Q1) and the third and fourth (Q3 and Q4) quartile journals: the larger angle separating the vertices reveals the existence of differential profiles. At the same time, the first and second quartiles are closer in this figure than in Fig. 1. Here the highest visibility is found for papers on clinical medicine, given the position of this theme category with respect to the first quartile vertex, while biology is located on the plane defined by vertices Q2–Q4.

Note in Fig. 2 that chemistry, which has a smaller weight in this than in the preceding analysis, is close to vertex Q1, while physics and earth–space are located on the Q1–Q2 plane.

In the following FCA, the theme category distribution is studied for multi- and non multi-authored papers, including the latter in the analysis as supplementary data. The results of this analysis are given in Fig. 3, which shows the different positions of the nine theme categories in visibility space, depending on the existence or otherwise of multi-authorship. The results must be interpreted in light of the direction and magnitude of the differences in position of each theme category.

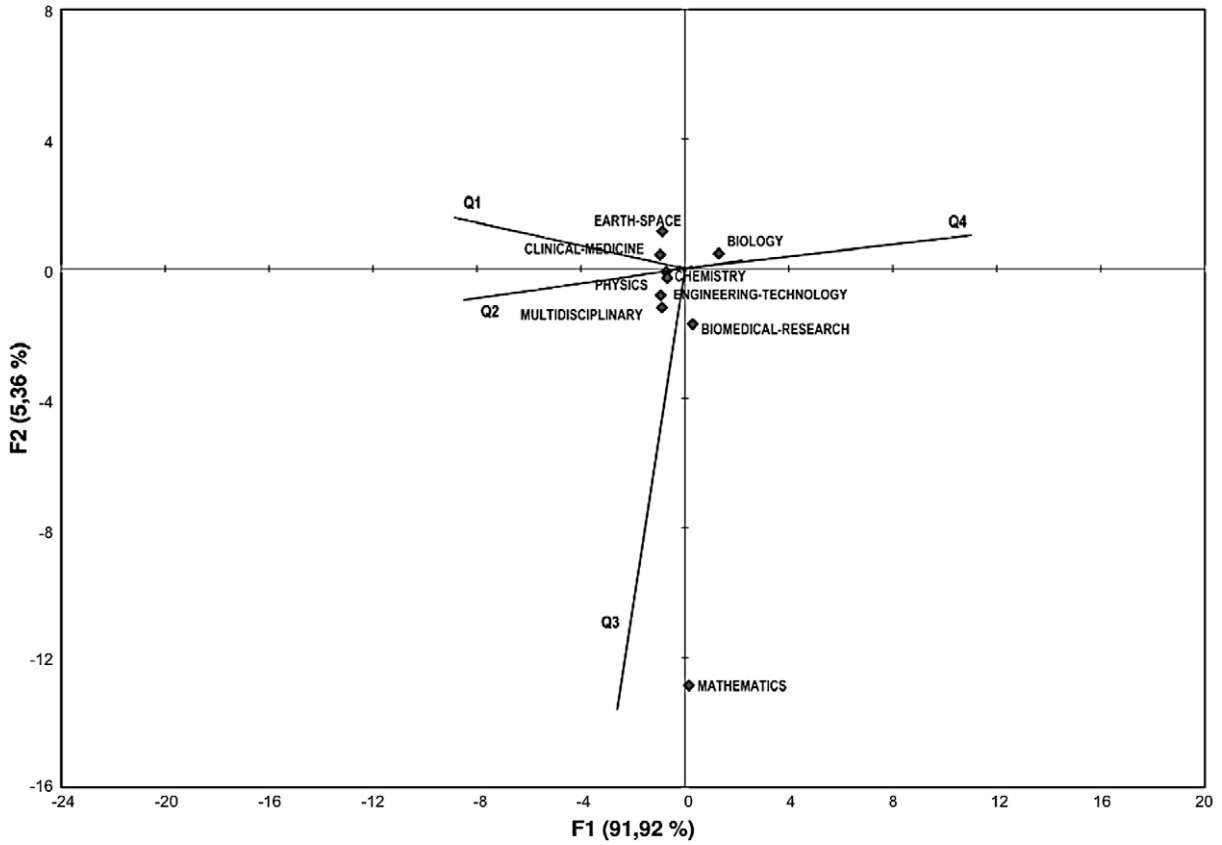

Fig. 4. Local multi-authorship (asymmetric FCA).

Clinical medicine, physics and engineering-technology are areas with high multi-authored paper visibility, for they are close to quartile 1 (Q1). As a general rule, the lack of multi-authorship is observed to go hand-in-hand with lower visibility in these categories, with non-multi-author positions shifted to the right, where the lower visibility quartiles (Q2, Q3, Q4) are located. Earth–space, in turn, barely exhibits any difference in position, an indication that visibility is essentially unaffected by the existence or otherwise of multi-authorship.

The different behaviour of biology and chemistry with respect to all other categories in terms of direction of shift is an indication of differences in multi-authorship profiles. Both chemistry and biology occupy peripheral positions, the former most prominently, for it is one of the areas most deeply impacted by multi-authorship patterns. Finally, biomedical research is the only case in which non-multi-authored papers are positioned further to the left, signifying greater visibility, than the multi-authored publications.

The analysis of multi-authored production depending on whether local or international partnering is involved is discussed below. Fig. 4 shows the FCA results for the theme category distributions with local collaboration, and Fig. 5 with international multi-authorship.

In Fig. 4 the position of clinical medicine reveals a researcher preference for publishing in higher visibility journals (Q1). The opposite tendency can be observed in biology, however, where most of the papers involving local multi-authorship are published in low visibility journals, as the position of this discipline with respect to the Q4 vertex shows. The publication profile of areas with lower production such as chemistry and physics is closer to vertices Q2 and Q3, whereas biomedical research is closer to the Q3–Q4 plane.

In any event, a far larger proportion of multi-authored papers involve international partnering. The results of the FCA conducted are given in Fig. 5. This graph shows a clear divide between the most highly visible papers (vertex Q1) and the rest, unlike the findings discussed above for local multi-authorship, where the distinction was between the least visible papers and the rest.

Fig. 5 also shows that most of the areas are located on the plane formed by vertices Q1–Q2–Q3; the biology papers constitute the exception, and are positioned to the left of the other subject areas.

Lastly, Fig. 6 shows the translation in theme categories with respect to paper visibility depending on the type of multi-authorship (international or local). The greater magnitude of the translation here than in the preceding analysis indicate that

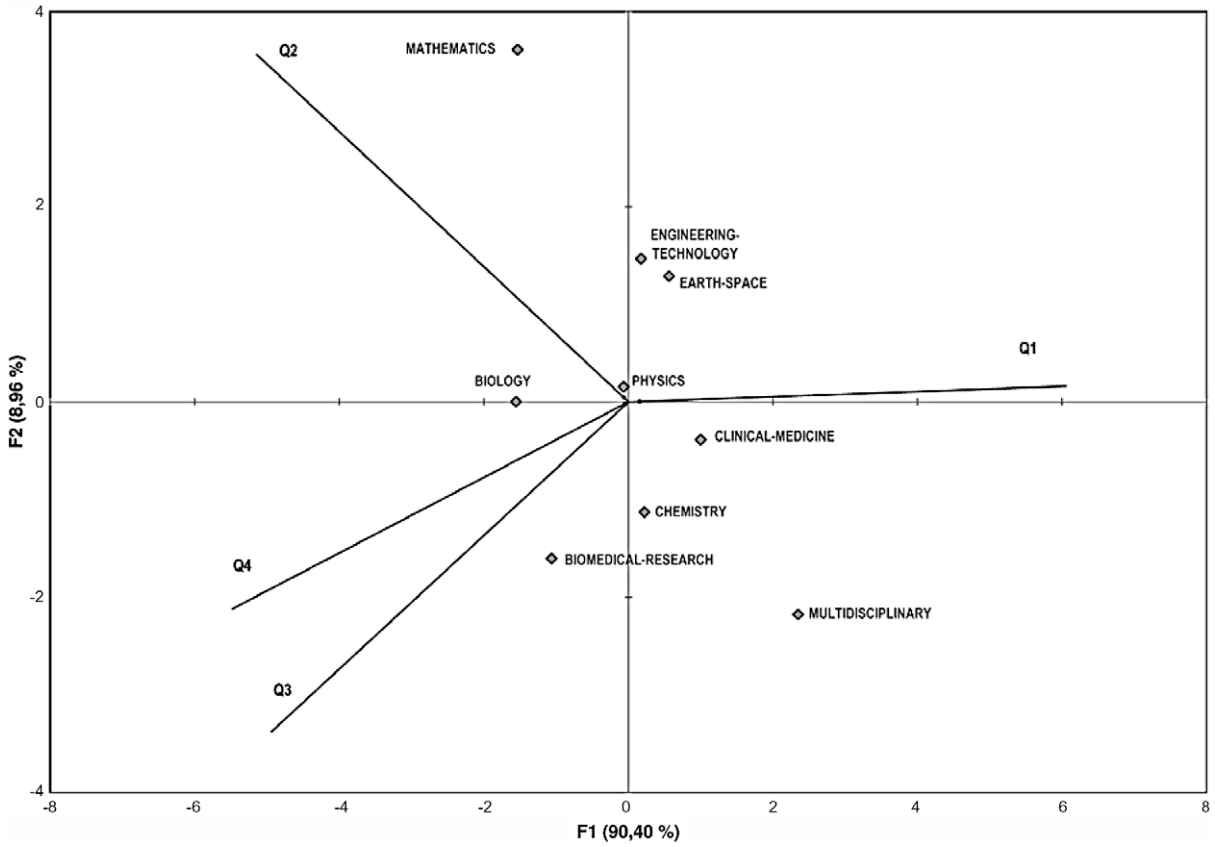

Fig. 5. International multi-authorship (asymmetric FCA).

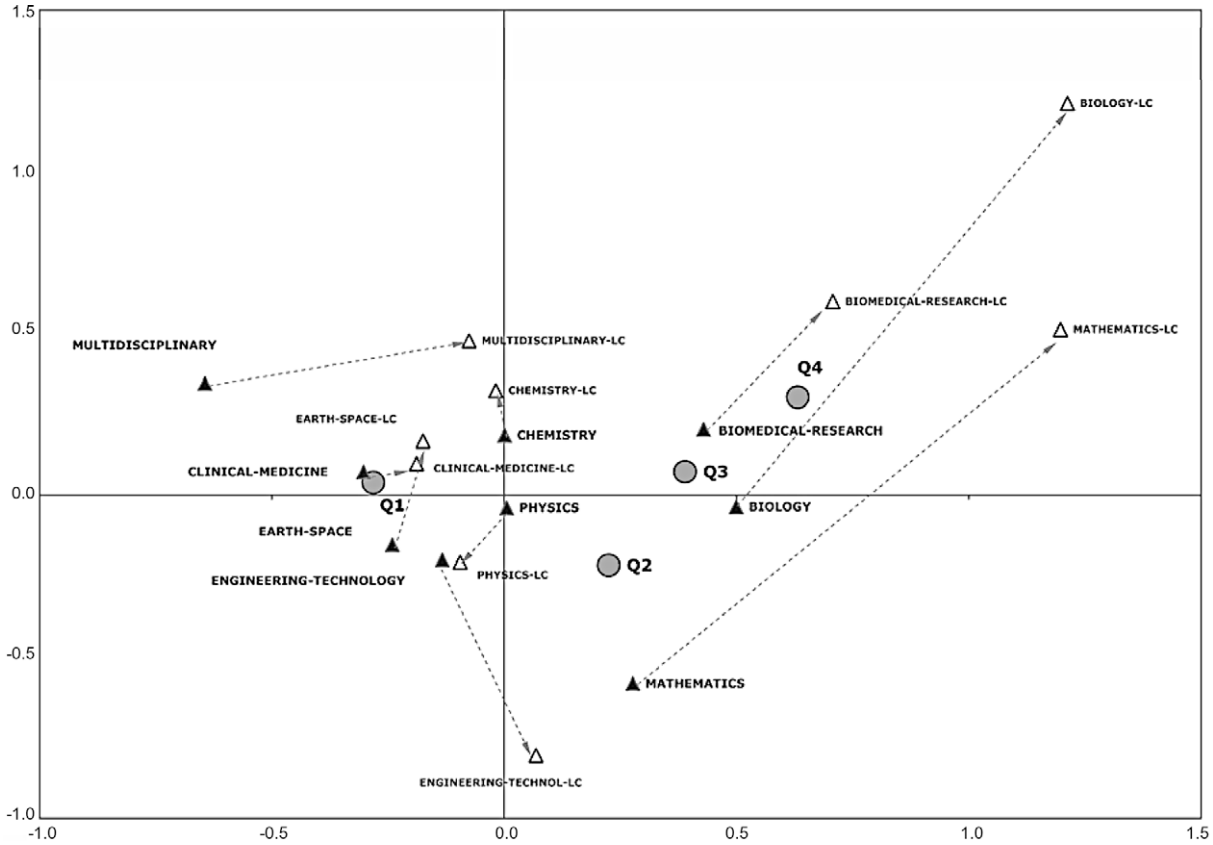

Fig. 6. Shift due to the type of multi-authorship (local or international) with respect to paper visibility (FCA with supplementary rows) (▲) International multi-authorship (Δ) Local multi-authorship.

visibility is affected more by the type of multi-authorship than by the existence or otherwise of partnering. The direction of the translation suggests that, generally speaking, visibility is lower when local multi-authorship is involved, in some cases substantially, such as in papers on mathematics or biology, and in other cases more moderately, such as in biomedical research and engineering-tech. Clinical medicine, chemistry, physics and earth–space are the categories least impacted by the type of multi-authorship, as attested by the smaller magnitude of the translation involved.

4. Discussion and conclusion

The furtherance of scientific cooperation not only enhances research, but also provides a way to optimize the use of resources and make significant contributions to knowledge, thereby furnishing better solutions to social needs. For this reason the study of the relationship between multi-authorship and research visibility is relevant, in light of the possible utility of the results for scientific policy makers (Russell, Ainsworth, & Narváez-Berthelemot, 2006).

In this analysis we use the journal impact factor to estimate research visibility, because it is important to keep in mind that "although the status of the journal in which a group publishes is an aspect of research performance in its own right, journal impact factor should not be used as surrogates of citation impact or a group's publications" (Moed, 2005a). Furthermore, the use of the quartiles of the rankings of the impact factor allows comparing in a very simple and reliable manner the visibility of the research published in the various scientific fields.

In the case of Puerto Rico, any analysis of the effect of the existence or otherwise of cooperation among researchers and the nature of such cooperation must take account of the predominant role and social relevance of the University of Puerto Rico, the most important institution of higher education on the island and its most representative scientific research centre. Furthermore, it should take account the strong relationship among academic units and scientific communities of the University of Puerto Rico and universities and other research institutions in the United States. Puerto Rico is a commonwealth of the USA and this status has a significant impact on political, economic, social and also scientific issues on the island. Nevertheless, more studies should be carried out in order to analyze the impact of political status on the characteristics of the scientific community in Puerto Rico. Consequently, the results of this paper must be interpreted against the backdrop of the weight of the performance of UPR researchers and the university's institutional research and publishing policies, along with the publishing activity generated in the country as a whole.

The most prominent finding revealed by the analysis of the behaviour of the different subject areas in the absence of inter-institutional authorship is the contrast between chemistry and biology. This contrast is also perceptible in the positions of the subject areas in relation to the lines representing the visibility quartile planes. Visibility is affected by multi-authorship in the sense that in the absence of inter-institutional cooperation, the visibility of publications declines, as can be seen in the shifts in point positions in Fig. 3. While this is more pronounced in some areas than in others, the existence of cooperation among researchers is a decisive factor in successful publishing and is taken into account by both domestic and international funding agencies.

In certain areas, the local or international nature of multi-authorship seems to have a much more significant effect on paper visibility than the mere existence or otherwise of partnering. The type of cooperation primarily affects biology, biomedical research and mathematics, which are associated with the third and fourth quartiles. The results show that publications are less visible when multi-authorship is local, and more visible when international cooperation is involved. Here also, however, the effect is less accentuated in certain subject areas, namely: clinical medicine, chemistry earth–space and, to a lesser degree, physics.

Be it said in this regard that the first group of categories is favoured by UPR system research investment policy (nature science alone receives around 20% of the total investment) (Castro Arroyo, 2004) and its strong links with the federal funding allocated by United States agencies such as the National Science Foundation (NSF), the National Institute of Health (NIH) and similar. Moreover, this group of categories concurs with areas where UPR system research is very intense. The shift in position in areas such as mathematics and biology observed in Fig. 6 stands as evidence that locally multi-authored papers are at a disadvantage in terms of visibility with respect to those published in conjunction with institutions in other countries.

As a general rule, the results obtained infer that scientific cooperation, particularly the international partnering that Moed (2005b) sustains has been rising in recent decades, favouring the greater impact of papers published, is observed in and is a determinant of research visibility in the Puerto Rican science system. Consequently, and inasmuch as the University of Puerto Rico is the institution with greatest weight in the island's scientific production, the results of studies of this nature may serve as an argument to further research policies that tend to strengthen the bonds with the international scientific community.

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