

# **Internationalisation of Nanotechnology R&D Process: A Longitudinal Study for the Collaboration Mechanism in the Nanotechnology Innovation System**

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## **Abstract**

The purpose of this research is to present the internationalisation of the nanotechnology R&D process with the help of patent documents. The research focuses on the progress of linkage mechanisms in a longitudinal setting to identify the impact of R&D collaboration on innovation activities. This study also looks at academic-industrial collaborations for each country to see if regional mechanisms favour particular kinds of collaboration. For example, current funding procedures arrangements encourage applications where academic and industrial parties are both involved. In some cases, fund providers do not consider applications if there is no more than one party is involved. Significant changes in the innovation system, as in the funding structure, draw our attention to influences on the collaboration mechanism. Some of the research questions that are asked include, but are not limited to: 1) What is the international collaboration rate (ICR) of R&D activities; and 2) How does the type of linkage (academic-industrial, co-sectorial, co-operative etc.) vary in comparison with 1990s and 2000s?

Other studies have done similar work in this field. Huang et al. (2003) presented a longitudinal patent analysis of nanotechnology patents between 1976 and 2002. Their work included content map analysis and citation network analysis by obtaining the required data from individual countries, institutions and technology fields. Genet et al (2012) examined the knowledge transfer model in nanotechnology by comparing it with other models utilised in the study of other emerging technologies, e.g. biotechnology and microelectronics. Another similar study was conducted by Beaudry and Schiffauerova (2012) on the collaboration effect and co-ownership network of Canadian nanotechnology inventors in terms of different factors on patent quality. Guan and Zhao's (2012) paper is highly related to our study as well, as they explored patent value based on complex network analysis in nanobio-pharmaceuticals and examined the collaboration between university and industry networks at organizational level. Likewise, the study of Ma and Lee (2008) examined the pattern of international collaboration amongst countries in inventive activities by using the patent assignee's information.

This paper uses a large patent data set from Thomson Innovation Database which increases the accuracy of results. Our study uses the lexical method and patent codes to gather the required data. To analyse changes in the linkage structure, the paper uses VantagePoint software with the tech mining method. This paper contributes to the field by using the software in a different setting to how other users have used it to illustrate and expand the usage of this tool. Moreover, this paper justifies the significance of the simultaneous usage of the lexical method and patent codes in patent data analysis.

Our findings show that the internationalisation of R&D collaboration is shifting from the national to the international level comparison with the last decade of the 20th century. In some cases it is at the global level as well since many large organisations R&D presence in various countries enhances globalisation of R&D. The findings on ICR show that organisations are not only relying on their national knowledge sources, as there is a noteworthy increase in ICR results and there is an internationalisation in collaborative R&D activities. Although there are many studies that show geographical distance as a great barrier for collaboration, our study shows that it has less impact with regard to the current collaboration network for the nanotechnology field. Our results indicate that current funding initiatives and collaboration

structures support academic and industrial collaboration. Even though there are many collaborative activities, co-operative activities between industrial players are still limited at this stage. It is assumed that this is due to the general nature of patenting activity and maintaining secrecy of information for competitive advantage.

The findings should be particularly useful for adopting technological strategies and Science & Technology policies, revealing strengths and weaknesses of R&D collaboration in the emerging nano-technological systems, existing country-level competencies and potential for absorption of relevant government spending. The research offers useful insights for Science & Technology policy makers. For those possible entrants to this field, it is beneficial to see the collaboration mechanism and the clusters in nanotechnology area.

**References:**

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