Research Trends

Volume 1 | Issue 5 Article 9

5-1-2008

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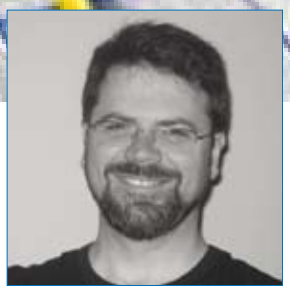
Research trends



Is nanoscale research slowing down?

Éric Archambault, President Science-Metrix

The number of papers published in nanoscience and nanotechnology has increased rapidly in the last 11 years. The compound annual growth rate (CAGR) from 1996 to 2006 was 16% and papers indexed in Scopus rose from 16,000 to 64,000. Calculating growth is never easy, as there is seldom one estimation method that gives the whole picture. For instance, we know the CAGR value is influenced by the growth in the coverage of Scopus itself. It is also necessary to consider that science may be growing and that nanoscience could be riding on that wave. Consequently, it is customary in bibliometrics to examine how a field is evolving as a percentage of the database used, in this case Scopus. One can see that in 1996, about 1.5% of papers indexed in Scopus were about nanoscience and this has increased to 4.2% of the database's contents in 2006, close to a threefold increase (see Figure 1).

Slowing growth

In light of these data, one can safely say that nanoscience research grew rapidly in the last decade. However, growth appears to be slowing in both absolute and relative terms. Bearing in mind that not all papers had been included in the database for 1996 when these data were calculated, it is more relevant to examine the curve that presents data in percentage terms. This curve is starting to look s-shaped, which suggests that growth has started to slow down. How can we explain this phenomenon? We will present four hypotheses, the most parsimonious first, followed by those of increasing complexity.

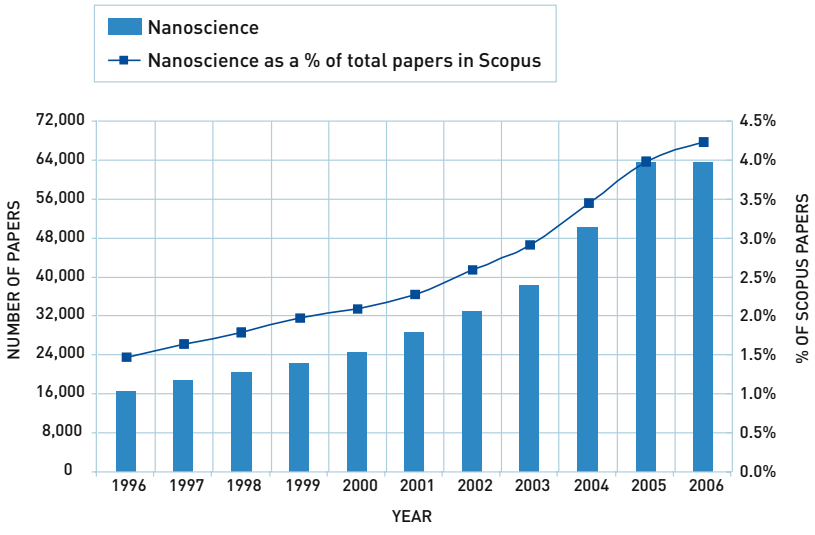


Figure 1 – The number of nanoscience papers indexed in Scopus between 1996 and 2006. Source: "Nanotechnology World R&D Report 2008", data from Scopus

The first hypothesis is that this slowdown is only a random variation along the exponential growth path observed. In addition to obtaining a strong R-Square value, it is indeed a requirement to accept that an exponential growth curve (or exponential regression curve) offers a robust model that observed data points be distributed randomly on each side of the curve. Consequently, it is possible that in the future, additional data points will show that a slowdown had not actually occurred – it was merely the normal occurrence of yearly variation.

From exponential to linear growth

The three remaining hypotheses are compatible with the observation that nanoscience research has started to look like an s-shaped curve, a type of growth process observed in biological but also in scientific, technological and social systems. This is not really surprising, as a system can never grow indefinitely. There are also limits to growth, as the means necessary to produce anything are always finite. For instance, there are only a certain number of researchers who can work on nanotechnology and once they are all mobilized and have learnt everything they can to perform and publish research in this field efficiently, their rate of publication will inevitably stabilize. For this reason, the second hypothesis is simply that nanotechnology is maturing, and that future growth will be more linear than exponential.

A third hypothesis would be linked with the idea that the field may be momentarily experiencing a slowdown and that a further boom cycle is forthcoming. If this model is appropriate, it would be akin to what German researcher Ulrich Schmoch calls "double-boom

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cycles" *(1)*. Schmoch argues that several domains, such as robotics and immobilized enzymes, evolved through an initial period of great patenting activity, followed by a slowdown and a less publicized follow-up cycle of high-frequency patenting. It is therefore possible that nanotechnology would be undergoing a slowdown after an initial boom in publishing and patenting and that a second boom would be forthcoming.

Obliteration by incorporation

The fourth hypothesis is that the use of nanoscale R&D is increasingly incorporated into mainstream S&T, which means that it is no longer being specifically mentioned as often or as prominently by researchers in their scientific publications and patents. This would mean that nanotechnology is undergoing a process analogous to "obliteration by incorporation". This concept, described by Robert Merton *(2)*, suggests a process by which the origin of an idea is forgotten due to prolonged use, as it enters the mainstream language of academic disciplines, and is thereafter no longer linked with its originators. An analogous situation in the development of a scientific discipline is provided by developments in the field of genomics. In this field, it was common in the 1990s to mention the use of the polymerase chain reaction (PCR) method in the title and the abstract of papers, but this was subsequently obliterated by incorporation. Indeed, it is now considered obvious that if one carries out gene sequencing, the PCR method is used. The same may be true of nanotechnology today and researchers may not mention that they are working at the nanoscale level as it may be deemed obvious to knowledgeable practitioners.

For further information about these reports, please **click here**.

References:

(1) Schmoch, U. (2007) "Double-boom cycles and the comeback of science-push and market-pull", *Research Policy*, Vol. 36, issue 7, pp. 1000–1015.

(2) Merton, R.K. (1949) *Social Theory and Social Structure*. New York: Free Press.

Country trends

United States research output continues to decline

An extensive body of research has consistently demonstrated that the US share of scientific articles published in peer-reviewed journals has been in decline over the last decade (see Figure 1). This has typically been ascribed to the effect of the developing knowledge economies of China and the four Asian Tiger nations, Taiwan, Singapore, Hong Kong and South Korea, and has not been considered a policy concern *(1)*. However, since the 1990s the absolute number of articles published by US-based researchers has plateaued (see Figure 2).

This flattening of scholarly output has been confirmed by the "Science and Engineering Indicators" (SEI) 2008 *(2)*, published in January by the US National Science Board. This biennial report contrasts this finding with strong annual growth in research funding in the US over the same period, from US$200 billion in 1997 to around US$340 billion (or 2.6% of GDP) in 2006. A companion policy statement, "Research and Development: Essential Foundation for U.S. Competitiveness in a Global Economy" *(3)*, nevertheless calls for a "strong national response" by further increasing the level of US government funding for basic research.

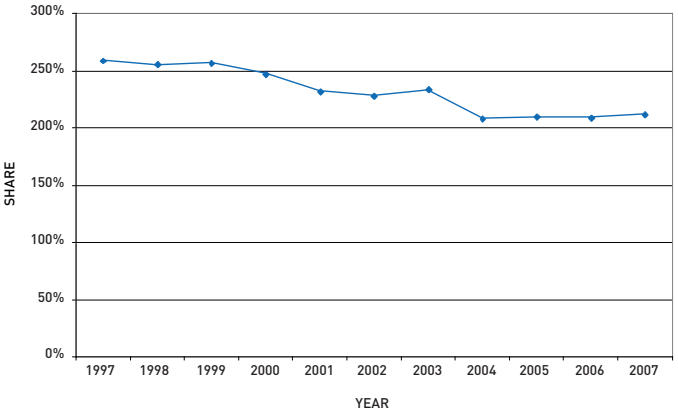

Figure 1 – Share of world articles published by US researchers, 1997–2007. Source: Scopus

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