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The science that changed our lives

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Section 1: Value of bibliometrics

The science that changed our lives – A tribute to Francis Narin and his contribution to understanding the linkage between science and innovation

Dr. Gali Halevi

A discussion about the societal effects of science would not be complete without discussing the linkage between basic science and patents. Patents are seen as the embodiment of research as they describe unique processes, methodologies and products which are the result of extensive scientific research. Patents are the link between science and market, between concepts and prototypes – and they serve as a step in the process of converting ideas into economic growth.

This topic was the focus of the American Competitiveness Initiative of 2006 (<http://georgewbush-whitehouse.archives.gov/stateoftheunion/2006/aci/>). One of the examples given by the White House at that time was the basic sciences that led to the development of the iPod™ (see Figure 1). This type of linkage between basic science and innovative products is at the heart of Francis Narin’s work as the first researcher to investigate this by studying the connections between basic research and innovation.

In what he himself denoted as “probably his last paper”, “Tracing the Paths from Basic Research to Economic Impact” (1), Francis Narin provides a glimpse into his pioneering work which changed the way government and industry measure the value of basic science. In his long career, Narin published over 50 articles on this linkage, examining citations exchanges between basic research and intellectual property in numerous subject areas, such as Biotechnology (2), Agriculture (3), Human Genome Mapping (4), and Eye Care Technologies (5). Collaborating with researchers from around the world, Narin dedicated his career to the study of the connections between scientific citations and patents, and measuring the economic strengths of countries, companies and even the stock market (6) through their scientific and intellectual property capabilities. Through the years, Narin and his colleagues were able to prove that basic science strengthens not only a country’s academic and scientific competency, but also has a direct effect on its economic prosperity through the translation of science into products and services.

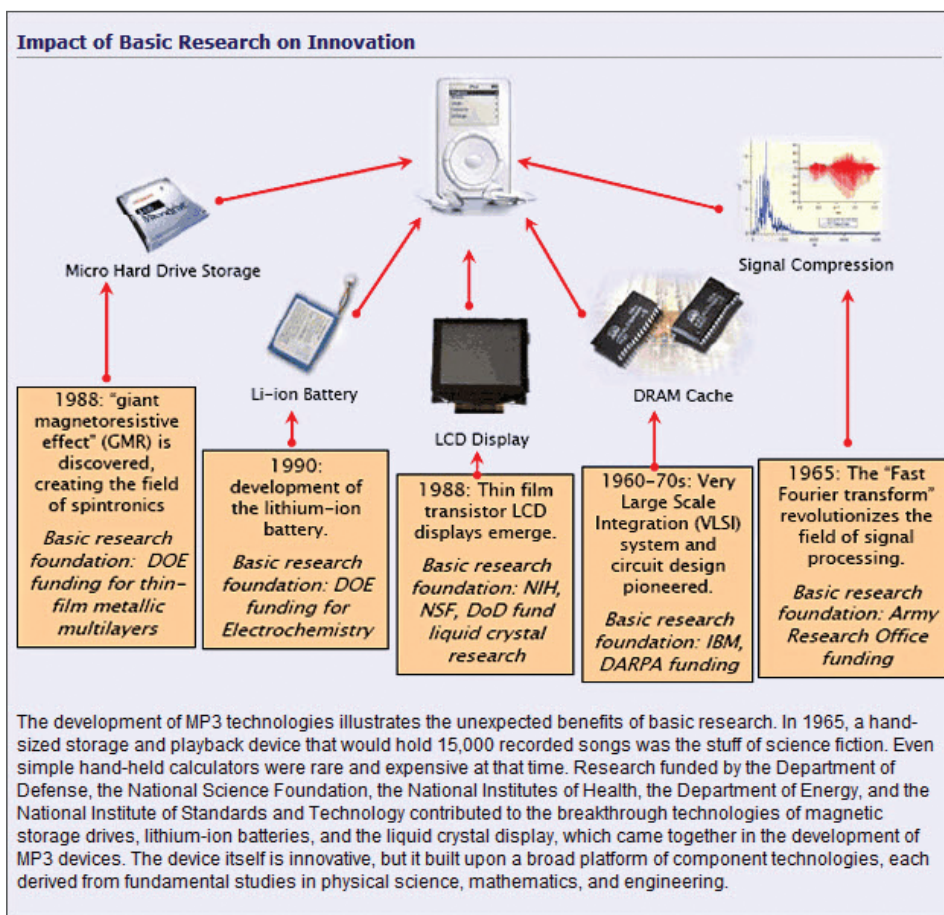


Figure 1: Impact of basic research on innovation. Source: <http://georgewbush-whitehouse.archives.gov/stateoftheunion/2006/aci/>

One of the examples given by Narin in his last article is the connection between his own "citation influence methodology" and the development of Google. The "citation influence methodology", developed in the 1970s, maps the citation links from a specific journal to the journals it cites most heavily and allows an influence map of sub-fields to be created. This methodology was later heavily cited by Sergey Brin and Larry Page as the basis for their PageRank internet search algorithm. PageRank became Google's most unique feature which differentiated it from others and enabled its enormous success.

In the words of Francis Narin and his colleagues at CHI Research, a firm pioneering in the analysis of patent citations:

"Science Linkage is a measure of the extent to which a company's technology builds upon cutting edge scientific research. It is calculated on the basis of the average number of references on a company's patents to scientific papers, as distinct from references to previous patents. Companies whose patents cite a large number of scientific papers are assumed to be working closely with the latest scientific developments." (7)

Economic strains and government deficits make Narin's work more important than ever. While governments are looking at cutting funding budgets as a way to balance national debt, scientific activities are often faced with depleting resources. Narin's work plays a central role in proving the importance of continuous government support of the sciences as they are directly linked to industrial advancement and economic growth. The article "The Increasing Linkage between U.S. Technology and Public Science" (8), published in 1997 by Narin, Hamilton and Olivastro, is one of Narin's seminal articles and has been cited over 300 times by researchers from various disciplines (see Figures 2-3). In this article the authors performed a systematic examination which proved the direct linkage between publicly funded science and its impact on industrial technology, while providing the empirical and methodological evidence needed for continuous government support of basic sciences. Whether for university or laboratory, publically funded research supported by government agencies such as NIH and NSF has been shown to be heavily cited in technological and innovative patents. The importance of such proof for facilitating budgetary allocations to scientific endeavors is illustrated by the fact that citations to this article still grow every year.

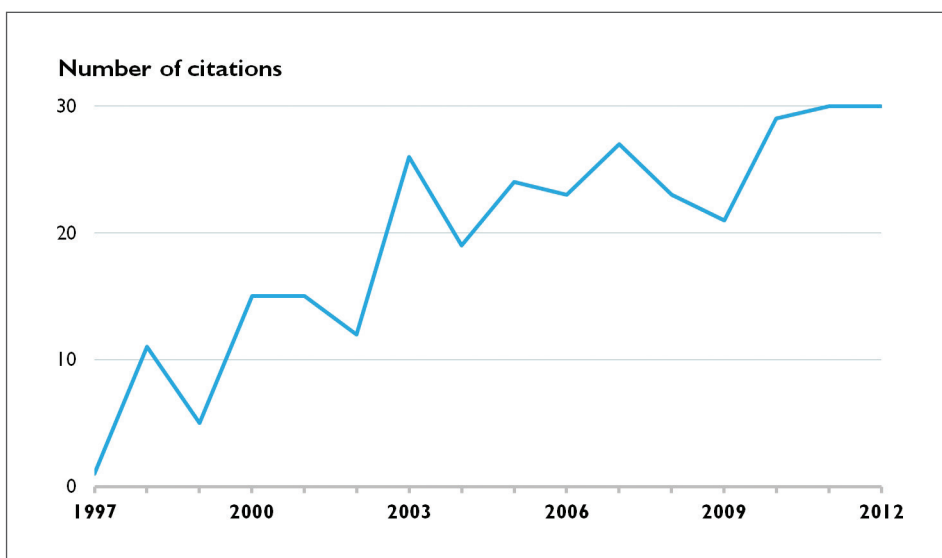


Figure 2: Number of citations to "The Increasing Linkage between U.S. Technology and Public Science" over time.

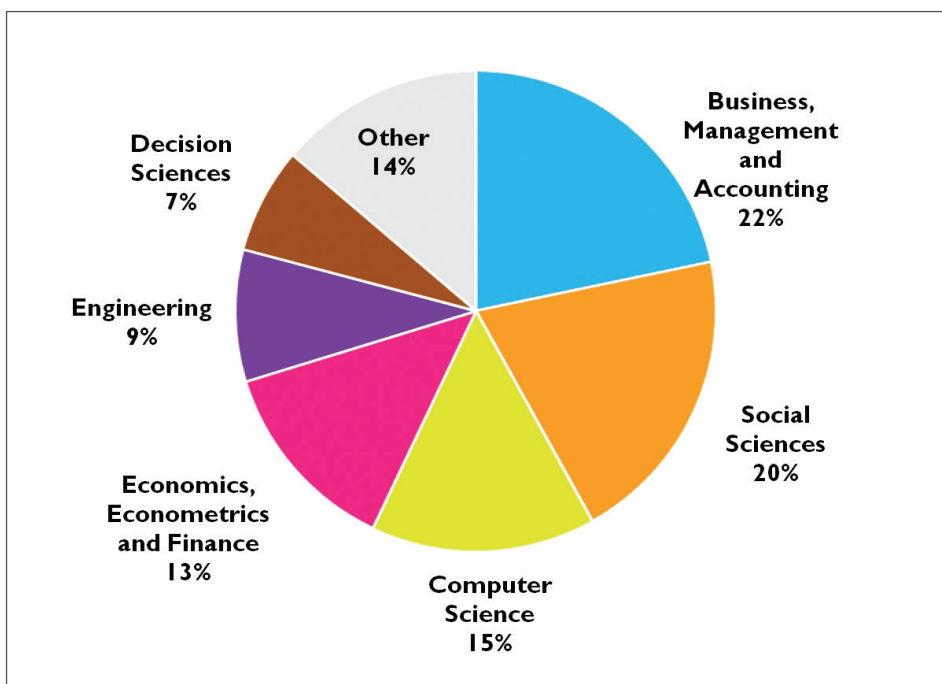


Figure 3: Disciplines citing "The Increasing Linkage between U.S. Technology and Public Science".

This innovative methodological investigation has led to an explosion of studies into the connection between basic science and innovation, which saw a surge in publications since 2008 as the economy plunged after the 2008 financial crisis (see Figure 4).

Narin's contribution to our understanding of the connection between basic research, innovation, industry and economy brought forth the need to demonstrate the importance of other disciplines to this process, for example, Social Sciences.

Using Narin's methodology of tracing non-patent literature citations in patents, Moed and Halevi demonstrated in this publication (9) how basic research in Library & Information Science was used in the development of search engines by technology companies, including the above mentioned citation influence methodology. The contribution of Social Sciences to innovation was the subject of the 1982 article by Tornatzky et al. (10), which argued that Social Sciences have been ignored in the general debate regarding national

productivity and innovation mainly because they are usually nonproprietary in nature. Yet, Social Science has been shown to be instrumental as a decision aid, a source of social technology and as a tool for understanding innovation and productivity. An example of this can be seen in Lavoie (11), who demonstrated the vital role of social scientists and their expertise in the field of regenerative medicine by “providing a comprehensive framework to include both technology and market conditions, as well as considering social, economic, and ethical values” (pp. 613).

Regardless of the discipline, tracking the connection between research and innovation is of immense importance, especially in turbulent economic times when the need to prove their economic and social value is crucial.

There are many factors working in today’s scientific landscape, most prevalent being budgetary constraints, that make the ability to measure Return on Investment (ROI) crucial for funding decisions. Academic and other publically funded research is being scrutinized in search of a metric or evaluative model that will enable decision makers to assess its impact on the economy and society as a whole. Francis Narin offers a sound methodology and empirical measurement to track these linkages and demonstrate the crucial role science plays in building a sustainable economy based on technological and industrial innovation. This type of study will remain important in years to come as the interest in assessing societal impact of scientific research is rapidly increasing, and the public becomes more involved in, and better informed of, funding policies using tax payers’ money.

The original “Technology in Retrospect and Critical Events in Science” (TRACES) report (1968) is now available [on our website](#).

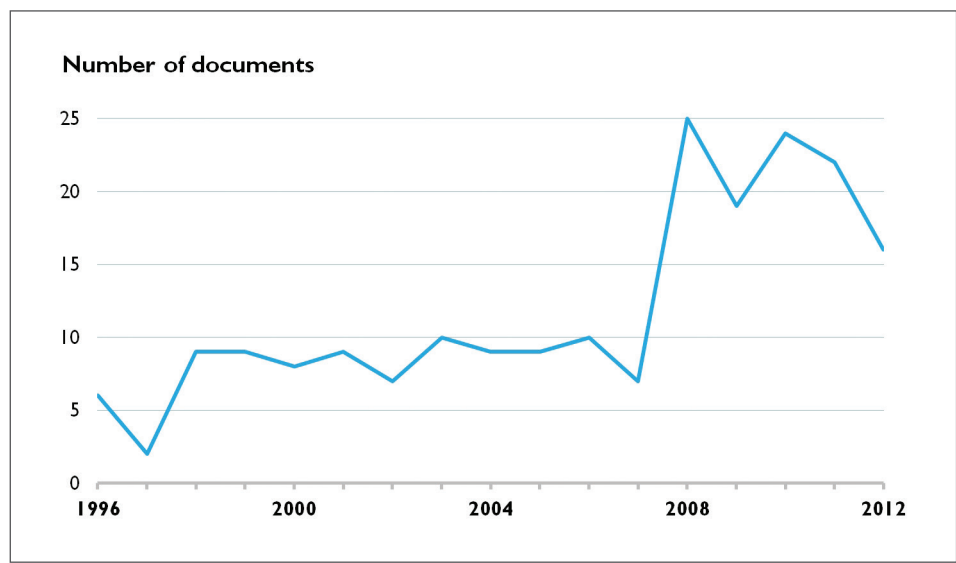


Figure 4: Publications focusing on basic science and innovation from 1996-2012.

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