"Speed to innovation": proxy indicator for evaluation of knowledge management at firm level

Ulf Sandstrom, Linkoping University, November 15, 2009

Introduction

Today, the success of firms relies more heavily on the ability to assimilate new knowledge (Zucker & Darby, 1996). The tacit nature of knowledge makes the ability to attract human resources a key activity in technology firms. The limited supply of knowledge and the increased technical complexity forces industry to enter into collaborative innovation structures. The ability to rely on "in-house" research and development diminishes (Cockburn & Henderson, 1998).

Early stage innovations are, with the use of intellectual property, being commercialized more often than before. Traditional basic research is being packaged into products. In biotechnology, "discoveries" of genes are being patent protected and packaged and sold as "research tools". Furthermore, the advances in information technology have made it possible to create knowledge based business models, where knowledge is packed and sold in the form of databases etc.

A starting point in this project is the study of knowledge management and the ability to execute "knowledge integration". The analysis will provide an answer to the question of the importance of industry-university collaboration for speed (pace) to innovation. Can firms that collaborate with universities better capture early stage research? Taken for granted in the context of this research is that a high pace to invention (patents) will pay off as high speed to market (innovation). This is, of course, a certain limitation to the study that needs be further investigated. Are innovating companies more efficient when they have a history of being fast to invention?

A recent study (Fabrizio, 2009) has shown that absorptive capacity largely affects the success of firms. Therefore, firms that produce and capture new knowledge have a competitive advantage.

Commercialization of early innovations implicate that knowledge has to be transferred from the discovering scientist to a company. A common conception is that knowledge can effectively be transferred through the use of publications and patents (Arrow, 1962). This very simple idea has, however, been questioned by many scholars, from David Mowery (1983) to Nathan Rosenberg (1990). In order to be able to use knowledge a firm has to develop their "absorptive capacity" which more or less becomes one of the determinants for successful innovation.

A renowned study of innovation by the NEBR economists Zucker and Darby (1996), suggests that the extent of collaboration of firm scientists with "star scientists" is a powerful predictor of its success. "5 articles coauthored by an academic star and the firm's scientist result in about 5 more products in development, 3.5 more products on the market, and 860 more employees."

The underlying reason for the importance of human relations when it comes to research and industry is the tacit nature of (scientific) knowledge. Tacit knowing, as opposed to explicit knowledge, cannot be transferred without the transfer of human capital (Foray, 2000; Amin & Cohendet, 2004). Zucker and Darby's studies reveal that these aspects to a large extent have been underestimated. They suggest that team production allows more knowledge capture of tacit, complex discoveries by firm scientist (Zucker, Darby & Armstrong, 2002). This is in line with the increased network type production structure of the knowledge based economy (see also Jensen et al. 2007; Darby et al., 1998).

Design, Data and Methods

We will investigate publication statistics e.g. in order to find out who are the star scientists of the field and which companies are the most frequent collaborators with universities. We use patent statistics to measure the speed to innovation. This indicator is used as a proxy for the success of the knowledge management exercised by companies. Accordingly, this indicator can be used in order to evaluate e.g. European firms in relation to American firms etc.

Currently, we are working with several sub-projects in order to test and develop the methodology. A first test has been done using semi-conductor patents and publications. The first study gave the result that there is a strong correlation between firms overall speed to innovation on the one hand and their collaboration with star scientist on the other. New studies are now developed for Medical Technology and for Paper and Pulp.

Data for Publication Analysis

Publication data will be based on downloads from “Web of Science”- WoS and selections based on publications from the larger companies’ active within the field (to be chosen). Qualitative analysis of the material is necessary in order for the selection to sufficiently capture the research field in question.

Identification of Star Scientists

We propose that “Star Scientist” can be indentified using the h-Index. H-Index is defined as the number of h papers with at least h citations each (Hirsch, 2005). Higher values signify that the actor has a large sum of highly cited papers. The top 1% will be defined as “Star Scientist”.

Industry-University Collaborations

The number of publications and academia-industry collaborations will be calculated for each industry actor. Especially, the number of collaborations with “Star Scientists” can be calculated for each industry actor. Percentage of collaboration with “Star Scientists” is an interesting indicator per company.

Patent Analysis Data

Patent data will be downloaded from “Derwent Innovations Index” using a similar search strategy as for the publications. The data covers WIPO patent publications 2006 to 2008.

Industry Actor Extraction

The Derwent “Assignee Codes” can be used to identify the relevant actors (e.g. industry actors with more than x number of research publications). Likewise the number of patents for each actor should be calculated and used as a factor/indicator.

Pace of Innovation

The patents list cited articles. These prior-art citations indicate on which prior research the patent builds (Fabrizio, 2009). In accordance with Fabrizio, the pace of innovation will be defined as the time lag between the cited articles and the new invention. If a patent list articles that are recent in time, it is an indication that the process from acquired knowledge to innovation has been fast. Thus, if the time lag between the cited articles and the invention is low, the **pace of innovation** is high.

The priority date of the patents will be used to indicate the time of innovation since this date is closed to when the invention was made (Fabrizio, 2009). The natural log of the time lag will be used since the distribution of the time lag is highly skewed. Unlike Fabrizio, we will use the natural log of individual time lags, not the log of the averages.

Limitations

There are several limitations to the research idea presented here, but it is necessary to consider our work as *proxy* indicator for successful knowledge work from the company side. As such, there are at the time being not so many indicators that can be useful and easy to extract from databases. At the same time it is necessary to develop larger tests for the stability of the indicator and to investigate whether the indicator is dependent on the field under study. Biotech firms have been the focus for Darby and Zucker, we are now entering into a project where we will use more engineering based technologies and firms. Furthermore, an important test of the indicator is, of course, whether there is a correlation to return on investment or profit for the company. This will be future work. At the conference the result of this second phase of the project will be reported and discussed.

References

Amin, A. & Cohendet, P., 2004. Architectures of Knowledge: firms, capabilities and communities. Oxford: Oxford Univ Press.

Cockburn, I.M., Henderson, R., 1998. Absorptive capacity, coauthoring behavior, and the organization of research in drug discovery. The Journal of Industrial Economics XLVI (2), 157–182.

Fabrizio, KR., 2009. Absorptive capacity and the search for innovation. Research Policy, 38: 255–267.

Foray, D.,2000. The Economics of Knowledge. Mass.: The MIT Press.

McMillan, G.S., Narin, F., Deeds, D.L., 2000. An analysis of the critical role of public science in innovation: the case of biotechnology. Research Policy 29, 1–8.

Mowery, DC 1983. Economic theory and government technology policy. Policy Sciences 16, (1): 27-43

Narin, F., 1995. Patents as indicators for the evaluation of industrial research output. SCIENTOMETRICS, 34 (3): 489-496 NOV-DEC 1995

Rosenberg, N. 1990. Why do firms do basic research (with their own money)? Research Policy 19 (2), 165-174.

Zucker, LG; Darby, MR (1996) Star scientists and institutional transformation: Patterns of invention and innovation in the formation of the biotechnology industry. PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA, 93 (23): 12709-12716.