Science-technology linkages in an emerging research platform: The case of combinatorial chemistry and biology

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This article focuses on issues concerning science and technology relationships posed by the emergence of a new drug discovery method, namely, combinatorial chemistry and biology. We assess the scientific content of combinatorial chemistry and biology using citations in patents to scientific journals and compare this research platform with biotechnology. We also identify the institutional affiliation of all the authors of the cited papers, which leads us to an analysis of knowledge spillovers between the main participants in the research network. Finally, we examine the relevance of localisation in the process of knowledge exchange with regard to EU countries and the US. The result of the analysis provides evidence to support the view that the inventive capacity of a country is dependent upon the basic research which is carried out, especially in universities and public research centres located in the inventor's country.

Introduction

Recent work in the economics of science and technological change as well as in science and technology studies has revived interest in the contribution of publicly funded research to industrial innovation. (For an exhaustive review of the literature on the economic benefits of publicly funded basic research see Martin et al., 1996.) Such interest has led to the expansion of better measurements, a development that largely stems from the availability of new databases of science and technology indicators combined with the development of powerful desktop computers and new software. Broadly speaking, scholars attempting to gauge the contributions of publicly funded research to industrial innovation have followed three methodological paths: (1) econometric studies, (2) survey and (3) case studies. Diversified though these methods may be, they have set the stage for a better theoretical understanding of the science-technology relationship and thereby contributed to easing the task of policymakers.
Although the studies that have applied these methodological tools share the general conclusion that public research may be a prime factor behind technological change and economic growth, it does not follow that technological change will necessarily generate economic growth. Thus, the picture that emerges can in no way be taken as being a map of all inventive activities. In other words, publicly funded research may well be conducive to more industrial innovations but will not yield evenly across technological sectors.

In this context, a quantitative assessment of the science-technology linkages characterising combinatorial chemistry and biology, an emerging research platform that spans a broad spectrum of applications from drug to new materials discoveries, should be well received. Embedded in a large network of firms, universities and research centres, combinatorial synthesis methods, albeit still in their infancy, are bound to be a spawning grounds for a stream of new products. However, despite its tremendous potential, no study has ever tried to examine the issue of public research and its contribution to combinatorial innovations. The purpose of this paper is to fill this void.

An overview of combinatorial chemistry and biology methods

Combinatorial synthesis methods are here defined as “the systematic and repetitive, covalent connection of a set of different ‘building blocks’ of varying structures to each other to yield a large array of diverse molecular entities” (Gallop et al., 1994, p. 1233). These technologies encompass a broad range of methodological schemes, the diversity of which reflects whether the building blocks are amino-acids, small chemical molecules, DNA or RNA; whether the synthesis of molecules is applied in solution, on a solid substrate or a biological system (i.e., living micro-organisms or preparations thereof such as phages, bacterial cells or DNA binding proteins); whether molecules are screened one at a time or simultaneously in a mixture; whether the biological target (i.e., molecular site of intervention) is known or unknown; whether the techniques are used for lead discovery (i.e., process of finding one or more compounds which interact with the target) or lead optimisation (i.e., process of synthesising variations of the lead compound); and so on. Yet, despite this diversity, there is little risk of over-categorising the various combinatorial synthesis methods if a clear distinction is established between the methods of solid-phase synthesis, parallel synthesis and combinatorial biology.

The first combinatorial method – solid-phase synthesis – was pioneered in 1982 by Árpad Furka at Eötvös University in Budapest (Hungary) (Furka, 1995; Borman, 1997). His “portioning-mixing” method, equally known as the split synthesis technique or the “divide, couple, and recombine” process, is most commonly carried out by tethering