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# The economic effects of basic research: evidence for embodied knowledge transfer via scientists' migration

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## Abstract

The paper argues that a substantial proportion of the wider economic benefits to society from publicly-funded basic research is associated with scientists' migration into the commercial sector of the innovation system. Rejecting a reduction of the research process to the propositional knowledge it produces, a set of hypotheses on the value of different types of knowledge is derived. The hypotheses are tested with empirical data obtained from scientists formerly employed by the Max Planck Society (MPS), one of the main organisations for basic research in the German innovation system. Findings indicate that rather than applying latest theoretical insights, scientists mainly transfer elements of knowledge that underlie complex problem-solving strategies in basic research.

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## 1. Introduction

The view that basic research potentially leads to a variety of economic benefits to society is not generally disputed. Whereas, early conventional accounts focus on how the results of basic research—as codified in scientific publications—travelled across time and space to eventually become incorporated in commercial innovations, more recent studies have pointed to additional mechanisms through which basic research supports innovation (for an overview, see [Salter and Martin, 2001](#)). This paper conceptualises and presents empirical evidence specifically on one of these mechanisms, namely the migration of scientists from basic research into industry. It argues that whenever such

migration takes place, it facilitates the transfer of the knowledge scientists previously developed and accumulated in the context of their research programmes. Even though the type of knowledge transferred and the effects this has naturally differs with the scientific background and the destination of each respective scientist, some important regularities are pointed out. Whilst the potential effects arising from migration are generally acknowledged in conceptual treatments, there is a lack of empirical studies on the subject. The paper is an attempt to contribute to filling this gap by taking the obvious step: going out and searching for scientists who at some point of their careers migrated into the commercial sector.

There is general agreement on the fact that the results of basic research contribute to innovation only over the medium- to long-term. By pointing to the much more direct link between basic research and

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industrial innovation established and maintained via scientists' migration, the study addresses some vital questions of science and technology policy. In fact, the findings spelled out below suggest that migration not only leads to embodied knowledge transfer *per se*, but that scientists' careers in industry have more widespread implications for how knowledge travels from basic research institutions into the commercial sector of the system. The paper will proceed with some further brief comments on the motivation of the study in Section 2. Section 3 proposes a classification of knowledge involved in the research process, which is the conceptual base on which the main hypotheses are derived in Section 4. After giving some information on the sample of scientists from which the data were obtained (Section 5), the hypotheses are tested against scientists' assessments on the value of basic research knowledge in industry in Section 6. Finally, some implications of the empirical findings are discussed in Section 7.

## 2. Motivation of the study

Recently, the migration of scientists into the commercial sector as well as within the commercial sector has increasingly gained attention. One line of empirical research in the national systems of innovation (NSI) literature takes the approach of linking up the public research sector with various industries by measuring inward and outward migration (Graversen, 2001), accounting for some of the personal and structural factors impacting on mobility. The feasibility of such studies depends on the availability of huge amounts of census data, which explains why nearly all of them focus on the Nordic countries where data protection legislation allows the collection of such data. For the French innovation system, labour market prospects for Ph.D.s in science and engineering have extensively been studied (Martinelli, 2001; Mangematin, 2000; Beltramo et al., 2001). A third line of research has focused on scientists' mobility in a life cycle context (Audretsch and Stephan, 1999) and the mobility of "star scientists" (Zucker et al., 1997).

All these studies share a notion that the migration of researchers must be somehow desirable, as knowledge is being transferred from public research institutions into firms where it can be commercialised by

leading to or contributing to innovations and technological improvements. In a sense though this leaves the knowledge concerned rather hidden, either by describing it with proxies like educational attainment or by implicitly assessing its social value via labour market outcomes. The relationship among embodied knowledge and migration is certainly most visible in the last category of studies, as they conceptualise mobility as a function of opportunities to appropriate embodied knowledge, built on the implicit assumption that it is actually possible to make reasonably accurate guesses on the potential value of the knowledge. In this sense, it is no surprise that studies that explicitly link mobility to appropriation behaviour nearly exclusively focus on the life sciences, where science and technology are argued to be currently "close".

The basic premise of the paper is that economic effects associated with scientists' migration are in fact broader, extending to many other disciplines, even if the incremental nature of innovation makes them somewhat less visible. The approach taken here is thus to address the issue directly by gathering data on embodied knowledge transfers among the people concerned. It is thus similar to the study by Martin and Irvine (1981), showing that a substantial proportion of the economic benefits from research in radio astronomy are associated with the migration into firms of the people formerly involved with the research.

From the theoretical perspective that dominates much of the literature on innovation, the relationship of knowledge from basic research and researcher migration does not logically follow. This is because the research process is reduced to its results, whose commercial relevance will in most cases not be given, as the fundamental insights from basic research are simply too remote (temporally speaking) from industrial applications. In the Section 3, a more heterogeneous characterisation of the knowledge in basic research will be introduced, so that their relevance can be tested in the context of people's actual experiences in the commercial sector.

This will allow to address two fundamental issues. First, there is the question *whether* the migration of scientists into the commercial sector systematically leads to embodied knowledge transfers, i.e. to transfers that are actually effective in that they contribute the innovative capacity of the system and to job performance more generally. Secondly, there is the

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