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# The economic benefits of publicly funded basic research: a critical review

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## Abstract

This article critically reviews the literature on the economic benefits of publicly funded basic research. In that literature, three main methodological approaches have been adopted — econometric studies, surveys and case studies. Econometric studies are subject to certain methodological limitations but they suggest that the economic benefits are very substantial. These studies have also highlighted the importance of spillovers and the existence of localisation effects in research. From the literature based on surveys and on case studies, it is clear that the benefits from public investment in basic research can take a variety of forms. We classify these into six main categories, reviewing the evidence on the nature and extent of each type. The relative importance of these different forms of benefit apparently varies with scientific field, technology and industrial sector. Consequently, no simple model of the economic benefits from basic research is possible. We reconsider the rationale for government funding of basic research, arguing that the traditional ‘market failure’ justification needs to be extended to take account of these different forms of benefit from basic research. The article concludes by identifying some of the policy implications that follow from this review. © 2001 Elsevier Science B.V. All rights reserved.

*Keywords:* Economic benefits; Basic research; Government funding

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## 1. Introduction

The relationship between publicly funded basic research and economic performance is an important one. Considerable government funds are spent on basic research in universities, institutes and elsewhere, yet scientists and research funding agencies constantly argue that more is needed. At the same time, governments face numerous competing demands for public funding. To many, the benefits associated with public spending on, say, health or education are more obvious than those from basic

research. However, as this article will show, there is extensive evidence that basic research does lead to considerable economic benefits, both direct and indirect. Those responsible for deciding how the limited public funds available are to be distributed (and for ensuring public accountability in relation to that expenditure) should therefore be familiar with the full range of relevant research. To this end, we review and assess the literature on the economic benefits associated with publicly funded basic research.

As we shall see, although the existing literature points to numerous benefits from publicly funded basic research, there are many flaws or gaps in the evidence. These stem from a variety of sources.

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Some are related to conceptual problems regarding the nature of basic research and how this may be changing, and the form of its outputs — whether this is information or knowledge (and whether the latter is codified or tacit), or whether other types of output such as trained people and new instrumentation are at least as important. There are also methodological issues about the approaches employed for analysing and assessing the benefits from research — for example, whether one can legitimately apply traditional economic tools such as production functions to science, or the validity of using scientific papers cited in patents as a measure of the links between science and technology. These conceptual and methodological problems point to areas where further research is needed.

In what follows, we first define the area of research covered in this study before examining in Section 3 the nature of the economic benefits of basic research and the different methodological approaches to measuring them. The next two sections then critically review and synthesise the main types of academic literature of relevance here. Section 4 deals with econometric studies on the relationship between research and productivity, the rates of return to research and ‘spillovers’. Section 5 distinguishes six main types of economic benefit from basic research and discusses empirical findings on each of these. The final section identifies the main lessons from the literature reviewed and the policy conclusions to be drawn.

## 2. Definitions and scope

The review is concerned primarily with *basic* research including both ‘curiosity-oriented’ research (undertaken primarily to acquire new knowledge for its own sake) and ‘strategic’ research (undertaken with some instrumental application in mind, although the precise process or product is not yet known).<sup>1</sup>

<sup>1</sup> This definition should not be taken as implying a simple linear model of innovation. Basic research is just one of many inputs to technology and innovation, and new technologies or innovations, in turn, can have an impact on basic research. It should also be noted that the concept of ‘strategic’ research is very similar to the OECD category of ‘(application) oriented’ basic research.

However, much of the literature reviewed uses other terms such as ‘science’, ‘academic research’ or just ‘research’, categories that are not identical with ‘basic research’ although they overlap considerably.<sup>2</sup> We have used the terminology adopted by authors since to rephrase everything in terms of ‘basic research’ would risk distorting their arguments or conclusions. The use of an overly strict definition of what is meant by ‘basic research’ would needlessly restrict the scope of this review. Indeed, the review suggests that simple definitions of research underplay the variety and heterogeneity of the links between research and innovation. Research can have different objectives depending on the perspective of the observer. It is more appropriate to think of the different categories of research and development as overlapping activities with gradual rather than substantial differences.

The study focuses on the *economic* benefits from basic research rather than the social, environmental or cultural benefits. However, there is a fuzzy boundary between the economic and non-economic benefits; for example, if a new medical treatment improves health and reduces the days of work lost to a particular illness, are the benefits economic or social? Given this uncertainty, we define ‘economic’ quite broadly. Moreover, the study considers not only economic benefits in the form of directly useful knowledge but also other less direct economic benefits such as competencies, techniques, instruments, networks and the ability to solve complex problems. Although it may be extremely difficult to quantify these benefits with precision, this does not mean they are not real and substantial.

Lastly, the study concentrates on *publicly funded* basic research.<sup>3</sup> This includes much of the basic

<sup>2</sup> In the United States, for example, about two-thirds of the research in universities is classified as ‘basic’, although this varies considerably across disciplines. Most analyses therefore focus on publicly funded research in general. (We are grateful to one of the referees for this point.)

<sup>3</sup> The study’s scope was set by the UK Treasury who commissioned the work on which this article is based. It is also based on work conducted in association with David Wolfe for The Partnership Group on Science and Engineering (PAGSE) in Canada (Wolfe and Salter, 1997). We are grateful to our co-authors in these two projects.

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