



MEASURING BEHAVIOURAL ADDITIONALITY

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Government R&D Funding and Company Behaviour

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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Foreword

Support of business R&D remains a major element of innovation policy across OECD countries. Many countries endeavour to increase business R&D expenditure with the ultimate aim of improving economic performance or achieving other societal objectives. New R&D funding programmes and tax incentives for business R&D have been introduced in a number of countries, and many existing programmes have been modified. Such developments have placed a higher priority on evaluating the effectiveness of government R&D support programmes. What is often needed, especially as policy makers attempt to compare the effectiveness of different policy instruments, is information on not only how much additional R&D is performed as a result of government support, but also how the government programme has affected conduct and direction of business R&D. Were different types of R&D conducted? Did the firm collaborate more with partners in the public or private sectors? Did the firm improve the management of its R&D activities? Measuring such *behavioural* changes remains difficult due to a range of conceptual and methodological challenges.

In order to improve the evaluation of business R&D support programmes, the OECD Working Party on Innovation and Technology Policy (TIP) launched a project to measure the so-called *behavioural additionality* effects. The project involved researchers and policy makers from eleven OECD countries who developed a common conceptual framework for behavioural additionality and experimented with different approaches for measuring it. Together, the group prepared twelve studies reporting on evaluations of behavioural additionality effects in programmes implemented in Australia, Austria, Belgium, Finland, Germany, Ireland, Japan, Korea, Norway, the United Kingdom, the United States, and the European Union's 5th Framework Programme. Most studies focused on programmes of direct government funding of business R&D, but others examined public-private partnership programmes and tax incentives for R&D.

This report synthesises the results of the project. Chapter 1 presents the key findings of the study, comparing findings of the country reports about the type and degree of behavioural changes induced by participation in government programmes and the different methodologies for evaluating them. The chapter was prepared by Luke Georghiou (University of Manchester) and Bart Clarysse (Vlerick Leuven Gent Management School). The remainder of the volume consists of summaries of the twelve country studies. They were prepared by: the Department of Industry, Tourism and Resources (Australia); Rahel Falk (Austrian Institute of Economic Research); Franziska Steyer (Joanneum Research, Austria); Bart Clarysse (Vlerick Leuven Gent Management School), Valentijn Bilsen and Geert Steurs (Idea Consult); Jary Hyvärinen (Tekes, Finland); Andreas Fier, Birgit Aschhoff and Heide Löhlein (Centre for European Economic Research, Germany); Jun Suzuki (Shibaura Institute of Technology) and Shuji Yumitori (New Energy and Industrial Technology Development Organisation, Japan); Taeyoung Shin (Science and Technology Policy Institute, Korea); Einar Lier Madsen and Bjørn Brastad (Nordland Research Institute, Norway); Khaleel Malik, Luke Georghiou and Hugh Cameron

(University of Manchester, United Kingdom); Stephanie Shipp, Lorel Wisniewski, Andrew Wang and Steve Campbell (US Advanced Technology Program) and Kerry Levin and Jennifer O'Brien (Westat, United States); and Wolfgang Polt (Joanneum Research, Austria) and Foteini Psarra (Atlantis Research Organisation, Greece). Jacqueline Allan of Forfás also contributed to the report information about Irish R&D funding programmes.

The report benefited from the contributions of many people and organisations in addition to those who prepared written chapters. Substantive input and comments were provided by Delegates to the OECD Committee for Scientific and Technological Policy and TIP Working Party, as well as from participants at two workshops organised during the course of the project. The first was co-organised by the OECD and the University of Manchester's Institute of Innovation Research on 10 and 11 May 2004. The second was co-organised with the Austrian Platform Fteval on 30 January and 1 February 2005. Preliminary planning meetings for the project were hosted by the Institute for the Promotion of Innovation by Science and Technology in Flanders, Belgium. These meetings and workshops allowed for the project plan to be developed, preliminary findings to be presented and discussed, and key conclusions to be identified. Luke Georghiou (University of Manchester) and Jan Larosse (IWT, Belgium and subsequently the European Commission) played key roles in initiating the study and developing its intellectual underpinnings. Jerry Sheehan and Shuji Tamura from the OECD managed the project and co-ordinated the preparation of the publication.

Other project information, including summaries and presentations from the aforementioned workshops, is available on the OECD Web site at www.oecd.org/sti/innovation.

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Executive Summary

Questions about the effectiveness of government financing of business R&D are of growing importance to policy makers. As they attempt to boost business R&D expenditure and improve its contribution to innovation, policy makers seek ways of evaluating not only how much additional business R&D spending is encouraged by government support, but also how government support influences the conduct and direction of business R&D. Does it encourage firms to pursue different types of R&D, or to include more collaboration in the R&D process? Do firms develop improved R&D management capabilities that lead to enduring changes in their R&D strategy and performance? Such issues are not typically addressed in traditional evaluations, which focus on assessing the amount of additional spending on R&D that resulted from government support or the additional outputs from the R&D process. Efforts to measure explicitly changes in the ways firms conduct R&D as a result of government policy instruments – *behavioural additionality* – have remained relatively under-developed.

Work conducted by the OECD Working Party on Innovation and Technology Policy (TIP) aims to address this deficiency by exploring methodologies for measuring behavioural additionality effects of government funding of business R&D. Using a common framework and conceptual understanding, but different methodological approaches, studies were made of eleven national R&D support programmes plus the European Union's Framework programme, to evaluate their behavioural additionality effects. Most of the work focused on direct financing of business R&D; but some studies examined the effects of loans or co-operative R&D programmes. To compare results and share experiences, two workshops were organised in Manchester and Vienna in 2004 and 2005, respectively.

This document summarises the results of the project, highlighting key findings from the country studies regarding the types of behavioural effects that were induced by government funding and the methodologies for measuring them. It shows that:

- The behavioural additionality concept offers policy makers a useful vocabulary for explaining the effects of policy interventions on firms and differentiating among types of effects (*e.g.* changes in level of effort versus changes in company behaviour). Such distinctions can help in designing effective policy instruments and selecting among different approaches for financing business R&D.
- A variety of behavioural additionality effects can be induced by government funding. Several country studies (*e.g.* Finland and Japan) showed that government funding not only allowed firms to accelerate the completion of R&D projects (enabling them to introduce new products or services into the market sooner), but also encouraged them to launch projects that entailed greater technological challenges that they might otherwise have pursued.

- Government funding can encourage firms to engage in more collaboration in R&D projects. The German study indicated that existing partnerships were intensified and new ones initiated as a result of government funding. The study of the US Advanced Technology Program showed that many consortia and joint projects were formed directly as a result of government funding, and that collaboration continued beyond the participation in a government-funded project – often on a different project.
- A range of different methodologies can be used for measuring behavioural additionality, each with its own strengths and weaknesses. Surveys allow for the collection of information from a large set of firms, but must often be based on the results of more in-depth interviews that identify the range of behavioural changes that can be induced by a particular government programme and the point in business innovation processes at which government assistance is sought. Econometric techniques can further highlight relationships between participation in a government R&D programme and changes in firm behaviour. A robust approach would combine methodologies.
- Methodologies need to be adapted to different types of target firms. Work in Belgium found that government R&D support played different roles in the innovation processes of different types of firms, *e.g.* large versus small firms and R&D-intensive firms versus firms in more traditional industries.

While most of the work focused on direct financing of business R&D (often cost-shared) the studies show that behavioural additionality concepts can be extended to other types of government interventions. Norway is embedding behavioural additionality into an examination of its R&D tax incentive. Austria included behavioural additionality in the evaluation of programmes that aim to link public and private sector research. As such, there are opportunities to embed the behavioural additionality approach into a broader range of policy evaluations, including those of public research organisations. Of course, all such work must recognise that some behavioural changes will be undesirable, especially as behavioural effect need not be intentional.

Future work can help further develop the concept of behavioural additionality and the methodologies for employing it. Such work can lead to a better understanding of the ways in which government R&D support interacts with and affects the strategies of firms can ultimately lead to the improved design and implementation of innovation policy instruments.

Chapter 1

INTRODUCTION AND SYNTHESIS

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Abstract. Traditional studies of the impact of public R&D grants on recipient firms have often failed to distinguish between a single sponsored project and the longer-term business innovation effort of which it is part. It is also difficult to define which effects to measure, and to attribute these to a specific government intervention. The concept of behavioural additionality – measuring the difference in firm behaviour resulting from a government intervention – was developed to overcome such difficulties. By reviewing the evidence on this topic, which has emerged through a series of national studies carried out in 2004 and 2005 under the auspices of the OECD’s Working Party on Innovation and Technology Policy (TIP), it has been found that a variety of behavioural additionality effects can be induced by government funding. Country studies conducted as part of this project show that government funding accelerated the completion of business R&D projects, expanded their scale and scope, and encouraged firms to conduct more challenging research. Government support also encouraged firms to engage in more collaboration, to pursue follow-up activities, and to improve their management. A better understanding is clearly needed of the way in which support interacts with, and affects, the strategies of firms. The concept of behavioural additionality suggests a systemic approach to this question.

Introduction

Growing policy interest in stimulating business R&D and innovation has heightened the need for more sophisticated evaluation tools. As the number and variety of policy instruments for boosting business R&D continue to rise, policy makers seek better information not only on the efficiency of individual measures, such as R&D grants and tax incentives, but also on the different types of effects they have on the conduct and direction of business R&D. For example, did participating firms conduct R&D in new technological fields that they had not previously explored? Did they co-operate more with other firms and/or public research organisations? Did they learn to manage their R&D in a more efficient manner? Understanding such changes in strategy and behaviour is essential both for improving the design and implementation of individual policy instruments and for constructing an efficient and complementary mix of policy instruments for business R&D support. It is also important for evaluating the effectiveness of policies that aim to

encourage particular types of behaviour, such as more collaborative research or more long-term research.

Despite the need for such information, most evaluations continue to assess the overall impact of projects that have been supported, rather than focusing on the contribution of the public support. To the extent that evaluations have addressed the specific contribution of public support, they have focused on either the amount of additional business R&D stimulated by government incentives – or the additional outputs that result from them. Little effort has been made to identify ways in which government policy influences the *type* of R&D conducted by firms or the *ways* in which such R&D is conducted. An emerging approach to evaluation – that of *behavioural additionality* – aims to measure explicitly changes in the ways firms conduct R&D as a result of government policy instruments. Such changes might be present whether or not the firms conducted more R&D or generated more output. As such, behavioural additionality aims to complement – not replace – more traditional approaches to evaluation that focus more on inputs and outputs to R&D processes. Considerable work is needed, however, to identify the types of behavioural effects that can be induced by government policies and to find reliable methodological approaches for measuring such changes in a way that can allow comparisons across policy instruments and across countries.

This chapter presents an introduction to, and synthesis of, work conducted to date under the auspices of the OECD Working Party on Innovation and Technology Policy (TIP) to develop effective approaches to measuring behavioural additionality. The first section introduces the concept of behavioural additionality. It reviews the problems inherent in measuring the contributions of public support to business R&D and outlines the theoretical underpinnings of the behavioural additionality approach, discussing the resource-based perspective for mapping the critical success factors behind an organisation's R&D process and the dynamic capabilities which typify large companies active in the development of new products. The second part explores means of evaluating behavioural additionality. It reviews the evidence that has emerged from a series of national studies carried out in 2004 and 2005, draws general conclusions regarding the policy ramifications of this work, and makes recommendations for taking it further.

Understanding behavioural additionality

Defining the problem

Interest in behavioural additionality is motivated by the limitations of more standard approaches to evaluation. Traditionally, studies of the impact of public R&D grants on recipient firms have encountered two major, related problems:

- The project fallacy: the failure to distinguish between a single sponsored project and the longer-term business innovation effort of which it is part.
- Measurement and attribution: difficulties defining which effects to measure and attributing them to a specific government intervention.

The project fallacy relates to the perspective of the sponsoring agency. From the agency's point of view, a grant or loan is made to a firm (or other organisation) and a set of expected deliverables is specified in a contract. These contract deliverables form the basis for subsequent evaluation. The problem arises because the recipient of the R&D support often views the publicly supported project as a contribution to a larger ongoing stream of work. It may be preceded and followed by projects with funding from other

private and public sources and/or be part of a larger activity with its own expected deliverables.¹ An accurate evaluation of the contribution of the government support to business innovation would therefore focus not on the achievement of the contracted deliverables, but rather the contribution the public support made to the firm's broader objectives. To answer to this question, the evaluation must concern itself with the interaction between the intervention and the organisation's strategy; it therefore must seek to understand the latter.

The measurement and attribution problem has several dimensions. The first is determining what to measure in the process of evaluation. Support for business R&D normally has economic objectives. That is, it typically aims to improve the innovative performance of a targeted group of firms and hence to contribute to economic growth and increased productivity. Social goals such as improved sustainability, health or employment may be pursued in parallel. If evaluations follow the traditional route of assessing project deliverables, their main concern will be to ask whether specific innovations resulted from the sponsored R&D and, if so, what contribution they made to the recipient firm's sales or processes. In other words, what was the impact of the innovation on the market or social environment? If the project fallacy questions the validity of attributing an innovation to a single intervention, the measurement and attribution problem questions whether the full effect of a sponsored project is captured by a particular innovation. The evidence from evaluation is that it most certainly is not.

Evaluators have developed instruments designed to detect indirect effects on firms of government R&D support. In doing so, they have included the factors that companies claim are important to them. Hence, the first survey instruments developed for evaluating collaborative programmes in the 1980s (which are essentially reproduced as the basis for most evaluations to this day – see Guy and Georghiou, 1991; Larédo and Callon, 1990; Bach *et al.*, 1995) were already seeking to ask firms about improvements to their knowledge base that would be applied elsewhere in their activities and about the benefits of networking or improved competence in the workforce.

Against this background, it seemed anomalous to evaluators that when questions about the difference made by government interventions were being addressed (as opposed to that of measuring project impact), a much more restrictive framework was being applied which seemed to screen out both the complexity of the effects of public support and many of the potential benefits (or indeed disbenefits). Matters came to head in that part of an evaluation termed the assessment of *additionality*. Additionality is an important concept in public finance, addressing the issue of whether public support is resulting in new activity rather than substituting for private support that would have occurred in the absence of the intervention. As applied to innovation, it can be considered in terms of additionalities in inputs (investments in R&D and innovation), throughput (implementation behaviour) and output (commercialisation of products and processes), as outlined in the following pages.

1. As an example, consider a large firm with an office devoted to identifying public funding opportunities that support the firm's ongoing efforts, or a small firm pursuing an innovation for which a succession of grants is sought to obtain the necessary financing on the right scale and for a sufficient period of time. In neither of these cases is the output of an individual grant or contract the outcome of the innovation effort.

Input additionality

Input additionality considers whether the funding the government provides to a firm supplements the firm's own expenditures or substitutes for them, *i.e.* for every dollar, euro or yen provided by the government, does the firm spend at least an additional dollar, euro or yen on R&D, or does the government funding crowd out (displace) the firm's investment?² The implication of this approach is that grants should be targeted to activities that would not have taken place without government support. This perspective dominates state aids regulations and, in particular, the EU requirement that subsidies should not be directed at a firm's core activities. This argument shows a lack of understanding of the role of R&D in business strategy and implies that firms face less uncertainty in areas related to their core business, which is not necessarily the case, especially for technological uncertainty. It nevertheless demonstrates the importance that additionality frameworks can have in real-world applications. The input additionality perspective makes three additional assumptions that do not necessarily hold for innovation: 1) there is a clear link between input and output of innovative activities; 2) returns to scale of the innovative activity are constant and indivisible; and 3) there is no difference in the nature of the output generated by public and private funding (Bach and Matt, 2003).

Output additionality

Because of the limitations of input additionality, researchers have become interested in measuring additionality in output instead of input. Output additionality is defined as the proportion of outputs that would not have been achieved without public support. This raises the question of determining outputs: is it papers and patents that resulted from R&D, or the downstream effects of R&D on sales of new products, processes and services? While this approach appears simple in concept, it requires major assumptions about the connection between the government support and the measured outcomes. The output of a project is rarely, if ever, a product, service or process alone. Even if a project fails to produce a specific, concrete output, the experience or training gained during the course of the project is itself an output that has additionality of its own. Specific projects can increase the specialised knowledge stock of the firm that is a strategic asset. At the system level, more fluid human capital is a stock that also increases the capacity to grow in subsequent cycles. Output additionality seems thus to be afflicted by even more problems than input additionality. This affliction is directly linked with the observation that the relation between input and output is complex and related in an unspecified way and hence that its observation requires an in-depth insight into how an organisation operates.

Behavioural additionality

Behavioural additionality can be defined as the difference in firm behaviour resulting from a government intervention. The concept was developed in response to empirical evaluation findings that illustrated that traditional formulations of additionality did not capture well the effects of programmes on large firms (Buisseret *et al.*, 1995). The assumption is that the behaviour is changed in a desirable direction, though an evaluation should also be sensitive to perverse effects, for example encouraging firms to take risks that they cannot afford. Behavioural additionality has generally been ignored in econometric studies of the effects of R&D support, which tend to focus on input additionality

2. See David *et al.*, 2000; Usher, 1994.

or output additionality by estimating additional R&D expenditure and comparing the performance of firms that received and did not receive public support. These are interesting questions, but in neither case is causality examined, nor is there an explicit or implicit model of how the firm uses public support. Such a model is integral to the concept of behavioural additionality. The concept is directly related to an in-depth examination of the dynamic capabilities which differentiate a company from its competitors. Such an approach draws on emerging theories of firm behaviour as relate to research and innovation.

Theoretical foundations

Behavioural additionality requires an understanding of business innovation processes. As long as impact of government R&D support is formulated in terms of input or output measures, evaluation treats the firm as a black box, the internal workings of which have no relevance for evaluation. As soon as intermediate results such as behavioural changes are considered to be a valid measure, however, the box is opened and a more in-depth view of the firm is needed. Two perspectives can provide this view: the resource-based view of the firm and the value innovation approach.

Resource-based view of the innovative firm

Resource-based theory links firm performance to its resources and capabilities (*e.g.* Wernerfelt, 1984; Rumelt, 1984; Teece, 1986; Barney, 1991). In this perspective, firms are considered to be bundles of resources that are unique and difficult to imitate, such as technological knowledge, human resources (including R&D personnel), and capital strength. Resources are defined rather broadly as all tangible and intangible assets semi-permanently tied to the firm. Questions of imitability play a central role in this perspective. Only those resources that are difficult to obtain lead to sustainable competitive advantages in a company. Hence, rather than the size of the R&D personnel force in a company, the quality of this R&D personnel is important, unless size permits a necessary critical mass or diversity of skills. If government R&D funding is to be additional, therefore, it should allow an increase in the company's resources in such a way that it results in a competitive advantage, for instance, by enabling a company to attract a unique skill which it would otherwise not be able to recruit or access. This may be more important than recruiting five relatively easy-to-find engineers because of funding provided by an R&D grant.

Resource-based theory also posits that firms possess dynamic capabilities to generate competitive advantage from their resources. Whereas resources are assets owned or controlled by the firm, dynamic capabilities refer to the firm's ability to assemble, integrate and deploy valued resources to accomplish its target (Amit and Shoemaker, 1993). Dynamic capabilities for large firms are related to the innovation process. Large parts of the new product development literature have focused on the rapid development of new products as a key determinant of success, and new product development processes are seen as the most important dynamic capabilities for firms (Nelson, 1991).³ Recent work points to several factors that are considered important in determining the success of a firm's product development efforts: 1) team tenure, 2) cross-functionality, 3) the presence of a heavy weight project leader, and 4) R&D partnerships. Changes in the management

3. For further information on new product development, see Brown and Eisenhardt, 1995; Wheelwright and Clark, 1992; Deeds *et al.*, 1999.

of innovation processes in companies that receive R&D subsidies can be considered an aspect of behavioural additionality.

In order to smoothen the innovation process, most companies have developed some sort of milestone or gate process, through which they push their innovation. The pipeline is developed in such a way as to optimise the project selection and development throughput time. The key success factors identified above, *i.e.* heavyweight team managers, cross-functional teams, team tenure and the use of partnerships are optimised along the innovation funnel. The milestone process in large companies often fits in a more strategic portfolio approach which allows the company to pursue a balance between the longer and shorter-run innovative projects. Focus gradually increases from idea generation, through feasibility or proof of concept, to product development, launch and market support.

Value innovation

In addition to the resource-based theory, which looks at the way companies can improve their competitive position vis-à-vis their competitors, strategic management scholars have analysed the need for value innovation, *i.e.* strategies to pursue new markets and/or build up new competencies that can result in an entirely new business (Kim and Mauborgne, 2004). In contrast to the resource-based perspective, which proposes resource building and construction as a way to leapfrog the competition, the value innovation perspective proposes that companies that grow the most are those that are able to get into entirely new market segments. Management experts such as Hamel (2002) and academic scholars such as Kim and Mauborgne (2004) conclude that most companies that are among the top in their industry did not obtain this position through outperforming the others, but because they had entered a new market segment that tended to be a growing one.

Box 1.1. Exploring the literature on the resource-based theory of the firm

A growing body of academic literature continues to develop and refine the resource-based view of the firm. Sometimes this literature presents contrasting views of similar concepts. For example, a variety of alternative resource classifications exist:

Grant (1991) classifies resources as tangible, intangible and personnel-based. Tangible resources include the financial capital and the physical assets of the firm such as plants, equipment and stocks of raw materials. Intangible resources encompass assets such as reputation, brand image and product quality. Finally, personnel-based resources include technical know-how and other knowledge resources including organisational culture, employee training, loyalty, etc.

Barney (1991) classifies resources as physical capital, human capital and organisational capital resources. According to his classification, physical capital resources include the physical technology used in the firm, a firm's plant and equipment, its geography and its access to raw materials. Human capital resources, on the other hand, include the training, experience, judgment, intelligence, relationships, and insights of individual managers and workers in the firm. Finally, organisational capital resources include a firm's formal reporting structure, its formal and informal planning, controlling and co-ordinating systems, as well as informal relationships among groups within a firm and between a firm and those in its environment.

Box 1.1. Exploring the literature on the resource-based theory of the firm
(continued)

In terms of factors that contribute to successful new product development processes, Brown and Eisenhardt (1995) found *team tenure* to be an important success factor in new product development. They found that teams with a short history of working together tend to lack efficient patterns and routines to be able to solve specific problems and be involved in information sharing. A second important success factor in the composition of the project team is the presence of *cross-functional teams*, i.e. teams with members from more than one functional area such as engineering, manufacturing, or marketing (Wheelwright and Clark, 1992; Brown and Eisenhardt, 1995).

The literature on new product development mentions the presence of a *heavyweight project leader* as a third important success factor (Wheelwright and Clark, 1992; Brown and Eisenhardt, 1995). A heavyweight project leader is a powerful manager, having direct access to, and responsibility for, the work of all those involved in the project. Furthermore, this role is a powerful linking pin, facilitating the external communication with, for example, customers and suppliers. Extensive involvement of customers and suppliers in new product development (NPD) is an important driver behind new product development performance, especially in turbulent environments (Iansiti, 1995; Brown and Eisenhardt, 1995).

Finally, the literature on strategic alliances indicates that *partnerships* for new product development are an important entrepreneurial strategy for both start-ups and established firms (e.g. Nohria, 1992; Eisenhardt and Schoonhoven, 1996). For new ventures, partnerships with other firms can supplement complementary resources on a timely basis, which can be a determining factor for effective product development.

A more recent stream in resource-based theory specifically addresses the organisational resources, also called the *dynamic capabilities* (e.g. Teece *et al.*, 1997; Eisenhardt and Martin, 2000), the *combinative capabilities* (Kogut and Zander, 1992) or *architectural competence* (Henderson and Cockburn, 1994). These scholars make a clear conceptual distinction between dynamic capabilities and other resources. The ‘process branch’, focusing on the process side (Mahoney, 1995), represents the dynamic capabilities turn in the RBV (resource-based view) school of thought. Resource-based scholars have only recently begun to explore systematically the dynamics of the processes by which firms build their competencies and engage in strategic maneuvering within a given industry.

Teece *et al.* (1997) state that dynamic capabilities reflect a firm’s ability to achieve new and innovative forms of competitive advantage. These encompass organisational and managerial processes (i.e. co-ordination/ integration, learning and reconfiguration), specific asset positions (i.e. technological and financial assets, as well as assets connected to the reputation) and path dependencies (i.e. the firm’s history).

Eisenhardt and Martin (2000) oppose the argument that dynamic capabilities are vague, tautological and non-operational. On the contrary, they state that dynamic capabilities consist of identifiable, specific strategic and organisational processes such as product development, forming alliances and strategic decision-making, and creating value for firms within dynamic markets by manipulating resources into new value-creating strategies. A direct implication of dynamic capabilities as specific processes is that one can build on the often extensive empirical research bases for each of these specific processes.

Whereas managing innovation in portfolio approaches and along funnels focuses on the process of speeding up the market entry of new products within the same industries or market segments, value innovation points to the long-term need to change an industry or industry segment regularly. This means that convincing companies to take a risk and enter a totally new market and/or build up a significant new competence can be of great value. R&D grants might have the additionality effect of changing a company's strategy and encouraging it to enter a new market.

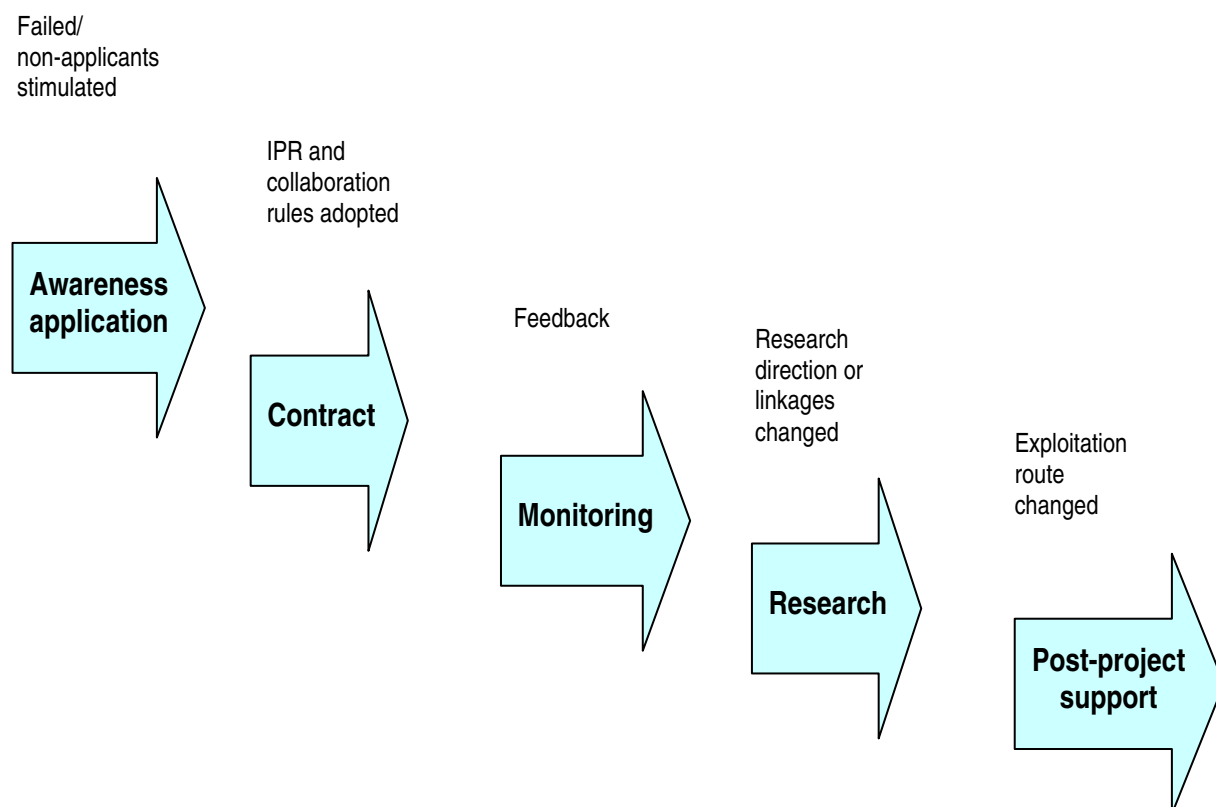
Implications for measuring additionality

The resource-based view of the firm and the value innovation perspective have significant implications for defining and evaluating the additionality of government R&D support programmes. From the resource-based perspective, input additionality translates into resources that are unique and difficult for other companies to imitate. However, traditional evaluations of input additionality do not have this perspective and use a much simpler measure of resource inputs. Input is boldly defined as the cumulation of resources, measured as the R&D personnel headcounts or the R&D expenditures. The firm is treated as a black box which takes the form of a production function assuming a clear link between input and output with constant returns to scale indifferent of the financial source.

The behavioural perspective is multi-layered. At its simplest, it is confined to the funded project and is manifested through questions about whether the support caused the firm to increase the scale of its activity in the chosen area, its scope in technological or other terms, and whether timing was affected (did the resources allow acceleration of development?) Questions on these issues have become fairly standard in evaluations, at least in Europe. Underpinning such questions, however, are broader theoretical issues that raise the question of how support interacts with and affects the strategies and capabilities of firms. In strategic terms, typical questions might involve the dynamic capabilities view such as whether the support has provided incentives for the firm to acquire new competences, ranging from project management skills to various technological and market routines and capabilities. Questions related to factors that are known to accelerate product development or marketing time of new products should also be taken into account. For instance, stimulating cross-functional teams, adapting project management skills, attracting different competencies or developing partnerships are good candidates. R&D grant support can also help to build new networks or co-ordinate systemic innovations such as those requiring establishment of standards, either between firms or between firms and the science base.

The value innovation perspective calls for questions that might change the strategic behaviour of large companies. R&D grants can help to overcome a lock-in failure by introducing a firm to a new or extended technology or market area. Some further discussion of the topic has appeared in the literature. Work to assess the effects of company support in New Zealand found that the behavioural additionality concept provided an explanation for several findings (Davenport *et al.*, 1998). Managers and policy administrators can exploit the occurrence of behavioural additionality to maximise the impact of a research policy, on the basis that modified behaviour is likely to strengthen a policy's latent ability to influence the creation of output additionality. The researchers conclude that managers and policy makers should be identifying those interventions that lead to sustained improvements in managerial practice, and in firm competitiveness. The aim then should be to manage their diffusion within firms and throughout industries.

Figure 1.1. Effects on companies through the grant cycle



Whether a project is additional or not is a separate question from that of the success of a project. Indeed, high additionality may easily be associated with an increased risk of failure because the intervention has tempted a firm to move beyond its competences or to undertake a project that was riskier than usual. Both of these may be positive effects overall if the payoff from a high-risk project exceeds the net benefits from a lower-risk strategy of supporting safer but lower-yield projects. There is also the case of high additionality where the policy maker induced the firm to move in the wrong direction because the policy maker misjudged the direction of technology or the market. Empirical evidence from Hervik (1997) in a study of successive policies in Norway found a clear trade-off between additionality and economic impact probably for the first reason given above. Luukkonen (2000) also cites empirical evidence to show that projects deemed as trivial by firms at the time of support may in the long run turn out to have been highly significant in their impacts, *e.g.* because they may build capacity in areas where firms have suffered from what Salmenkaita and Salo (2002) have subsequently labelled “anticipatory myopia” (a concept that related well to technological lock-in).⁴

It is also important to recognise that the potential to influence firm behaviour occurs throughout the cycle of grant support from the initial announcement of a support opportunity through the issuing of a contract, the research itself and ultimately post-project support (Figure 1.1). The announcement of a new funding programme may even stimulate those who do not move into an area. Contracts bring with them procedures in such

4. Luukkonen (2000) used this evidence to criticise the additionality concept on the grounds that it is insufficient to reveal the usefulness of public support.

areas as collaboration and the treatment of intellectual property. Monitoring obligations may affect internal project management procedures. Research directions may be influenced as the exploitation routes if, for example, a firm gains a higher profile with venture capital. In the design of evaluations this broader view of policy instruments is needed.

Rationales for government intervention

How can the different types or manifestations of additionality be reconciled with current thinking on rationales for innovation policy? The market failure rationale needs little explanation here. Following Arrow (1962) the argument follows the general line of positive spillovers, non-appropriability and uncertainty creating a situation in which there is underinvestment in research (and by implication in other knowledge-based innovative activities) in comparison with the socially desirable level. As argued previously (Metcalf and Georghiou, 1998) the market failure perspective has been highly successful in providing a general rationale for policy intervention, but it is inherently unable to provide specific guidance on policy prescriptions.

Lipsey and Carlaw (1998) in a study aiming to show that neo-classical and structuralist evolutionary policies lead one to different conclusions in a technology policy evaluation, engage in a discussion of how additionality (or in Canadian terminology, *incrementality*) would be assessed under each perspective. They argue that a neo-classical approach would insist at least on what they term a “narrow test of incrementality” being that “some technology is developed or installed that would not have been produced in the absence of the policy or programme under consideration”. This corresponds to output additionality as discussed above. They argue that the neo-classical approach could also go further to demand a test of “ideal incrementality” in which the policy is demonstrated to be an optimal use of government expenditure. This invokes a series of tests attributed to the Canadian economist Dan Usher:

- The project must be the least costly way to undertake the desired level of R&D investment.
- Social benefits must exceed the subsidy (including transaction costs, deadweight and other leakages).
- Discounted benefits must exceed discounted costs of intervention.

It is clear that the information requirements of these tests far exceed what is likely to be available in any practical situation and may in themselves place undue transaction costs upon the subsidy. The crucial criticism which Lipsey and Carlaw make is that the structuralist/evolutionary perspective would apply only a “weak test of incrementality”, defined as “something the policy makers are trying to do has happened as a result of their expenditure of funds”. The difference from the neo-classical perspective is that, with no attempt at optimality, the desired effects are less clearly specified (to allow for inherent variability between firms) and include structural changes and enhancements of firms’ capabilities. For innovation policies such as R&D subsidies where the main aim is to provide resources to the firm, it seems reasonable to expect both kinds of effect to be evident (the targeted product and the longer-term enhancements). However, when we come to consider innovation policies which do not involve the provision of finance, this distinction becomes crucial.

Effects may or may not be intentional on the part of either the policymaker or the recipient of funding. It is also of interest to assess the *persistence* of such effects. While input and output additionality operate at a point in time, behavioural additionality effects may be expected to endure beyond the period of R&D and to be integrated into the general capabilities of the firm (Georghiou, 2002). Bach and Matt distinguish these dimensions of behavioural additionality by labelling them “cognitive capacity additionality”, but the keyword here is *capacity*.

Measuring behavioural additionality

Making the behavioural additionality concept operational for evaluators implies developing techniques for measuring it. Earlier work on a measurement strategy for behavioural additionality (Georghiou, 2004) argued that different questions would be relevant for large R&D intensive firms, traditional small and medium-sized enterprises (SMEs) and technology-based start-up firms, each group of which would tend to a different type of relationship between their technology and business strategies. A distinction was also made between the operational and strategic levels, each of which could be explored at project or company level. Operational issues involve improvements in project management procedures or broader acquisition of management capabilities. Strategic issues could include, for example, new alliances at project level or broader changes in the technological or market direction of the firm.

In terms of identifying effects of government funding on firm strategies, many possible dimensions can be identified:

- *Knowledge acquisition* includes issues of how R&D is organised within the firm, e.g. corporate versus business level R&D and linkages between them. In some cases corporate R&D is only sustained because of the cumulative effects of public funding. Location decisions about R&D, including international ones, may be influenced by technology policies (see also capital investment below). Knowledge acquisition has increasingly become a matter of managing external networks. With the growth of collaborative R&D, outsourcing to specialist suppliers and universities and the planned acquisition of start-up firms either on the market or through corporate venturing, we are seeing the emergence of a new industrial ecology (Coombs and Georghiou, 2002). Innovation policies founded in the systems perspective place a heavy focus on the formation and promotion of the resulting networks and hence this is a fertile area in which to look for behavioural additionality effects. However, it is important to get an assessment of the values of the linkages as at one extreme they could be a cost rather than a benefit.
- *Human resources* can be a direct aim of technology policy, as with schemes that subsidise the hiring of researchers, or an indirect result as in the case of a company’s researchers upgrading their skills or qualifications within the context of a funded project. Management skills can also be acquired as a result of taking part in a project. Examples from past evaluations include small firms learning about control procedures through compliance with planning and monitoring requirements demanded by a funding agency, or large firms using international collaborative projects as a means of training managers in internationalisation skills. These acquired competences can be significant for future firm performance. A recent example from an evaluation in Japan showed that a team which had taken part in a

project did not develop anything of great value within the project but subsequently went on to apply their acquired knowledge in other more successful developments.

- *Capital investment strategy* is not at first sight a behavioural issue but it is possible that R&D support may influence the location of a company's facilities or even an entire laboratory, with long-term consequences for the region concerned and for the company's future networking. It is also possible that support may induce a firm to acquire equipment that it would not otherwise have, and as a result move in a different direction or in some cases the same direction more quickly.
- *Market position* is another area of possible influence. R&D may transform a follower into a leader, on the basis of new processes for example. The innovative project may also introduce firms to new customers or new markets. These may extend to products and services other than those initially supported.
- *Strategies for manufacturing or service provision* may also evolve in the context of public support. This could be directly as result of a process-oriented project or arise indirectly because the advance in a firm's knowledge enables it to change its production or service delivery methods. An example could be increasing use of e-commerce to reduce inventories.
- *Corporate responsibility and sustainability* can be an explicit aim of a project or form a further type of externality. For example, innovative activity may result in reduced use of material or energy inputs and in turn may stimulate a reorganisation within the firm to take advantage of this.

Table 1.1. Questions classified according to type of additionality

Output additionality		New products on the market New patents Market share Profitability	
Behavioural additionality		Project level	Company level
	Strategy	▪ Additional external finance (loans VC) ▪ Strategic partners ▪ Slack	▪ Improvement of production process ▪ Change patent strategy ▪ Competitiveness ▪ Image ▪ Future innovation potential ▪ Location of R&D facilities ▪ Enter a new technological domain
	Operation	▪ Product quality ▪ Faster development time ▪ Collaboration ▪ Larger scale ▪ Higher risk/return projects	▪ Indirect benefit to other department and business units ▪ Positive service / supply of product ▪ Formalised innovation process ▪ Better innovation management capabilities ▪ Prolonged collaboration ▪ Upgrade of human resources / research equipment
Input additionality		Increase in R&D budget	

Source: Clarysse *et al.* (2004).

Topics for questions can be classified according to the four dimensions identified above and also in relation to type of additionality (Table 1.1).⁵

Findings of OECD work

Work of the OECD Working Party on Innovation and Technology Policy has explored means of measuring behavioural additionality via a series of national studies. These studies focus mostly on the evaluation of grant support schemes for industrial R&D.⁶ As noted above, Georghiou (2004) proposed a series of questions that could be used to measure behavioural additionality in the context of grant support for R&D. Several countries integrated versions of these questions into ongoing evaluations, while others experimented with different approaches (Table 1.2).

Table 1.2. **Programmes addressed and methodology**

Country	Programme	Methodology
Australia	R&D Start programme	100 firms interviewed by telephone or in person
Austria (Case 1)	Austrian federal R&D support scheme (FFF)	Compares survey responses about hypothetical scenarios (1 000 firms) to actual consequences documented in administrative records (420 firms)
Austria (Case 2)	Kplus funding initiative	Compares questionnaire-based survey of 118 firms (75% of those surveyed) with responses to the 3 rd Community Innovation Survey
Belgium	IWT support programme	Telephone interviews plus additional in-take interviews for large R&D-intensive firms
Finland	Tekes funding programme	Questionnaire-based survey (193 respondents)
Germany	Public R&D project funding	Data from CIS Germany: 659 firms Telephone interviews: 203 responded (39% response rate)
Japan	R&D projects of NEDO	Interviews and questionnaires (501 firms and other institutions responded)
Korea	General R&D funding	Econometric analysis based on public and private sector R&D data
Norway	Loans and grants from Innovation Norway	Interviews (807 firms responded, 67% response rate)
United Kingdom	SMART and LINK initiatives	10 in-depth case studies of firms looking at grant histories
United States	Advanced Technology Program	Online survey with follow-up by telephone interview (81% response rate)
EU	5 th Framework Programme for Research and Technology Development (FP5)	Questionnaire survey: 1 700 responses Also survey to rejected applicants

While all of the studies use questionnaires, interviews or a combination of the two, the specific approaches vary considerably in terms of media used (mail, Web, telephone, face-to-face), types of people interviewed (single or multiple, manager or researcher), and analytical techniques. Final results of these studies are summarised in this volume: eleven evaluations of specific national programmes, plus one evaluation of the EU's Fifth Frame-

5. This classification is derived from that used by Clarysse *et al.* (2004) in developing an evaluation tool for measuring behavioural additionality in Flemish R&D support programmes.
6. In Korea, an econometric study explored the effect of public R&D expenditure on private R&D investment at the aggregate level, comparing input additionality of subsidy with expenditure on government research. The Association for Technology Implementation in Europe (TAFTIE), an association of agencies involved in administering R&D grant programmes, explored additionality in the context of developing strategies for innovation support agencies to give value-added to their clients.

work Programme. Short summaries of these national experiences are provided below, describing the methodological approach used and a selection of key findings.⁷

Australia

The Australian study aimed to identify and determine the impact of the *R&D Start* programme on firm behaviour (see Chapter 2). One hundred small research-intensive companies that had received an R&D Start grant were interviewed or surveyed (the sample represented 9% of participants in the programme), and the analysis included both qualitative and quantitative elements.

The study found that receipt of an R&D Start grant induced substantial behavioural changes in all of the firms which participated in the study, although the nature and degree of change varied. Participants advised that the provision of a grant encouraged them to apply for other forms of government assistance, generated and/or entrenched changes in project management and facilitated the formation of new collaboration with universities and public laboratories which are expected to continue. Furthermore, a majority of firms reported that they had gained an increased understanding of the benefits of R&D and an improved innovation culture, despite already being R&D performers. The survey found that 63% of respondents would have continued with the same project had government funding not been provided, but the project would have taken longer and, in the majority of cases, would have been undertaken on a smaller scale and with less ambitious outcomes.

Future work will extend this study to 100 firms receiving an entitlement-based R&D tax concession. These firms will be asked the same set of questions and a comparative analysis of the changes in behaviour resulting from grants-based and entitlement-based support will be completed.

Austria

Two studies were conducted on different Austrian R&D programmes. The first examines behavioural changes induced by funding from the FFF, Austria's Federal R&D support scheme and the largest programme for financing business R&D in Austria (see Chapter 3). It combines a survey-based approach with an econometric analysis. The survey included both recipients and non-recipients of FFF awards and compared responses regarding hypothetical scenarios (*e.g.* would you have cancelled the project if you had not received FFF support?) with those of actual scenarios (*e.g.* did you cancel the project after not receiving an award?). The econometric analysis estimated the extent to which the stock of R&D personnel was affected by public money for R&D. The analysis made use of the FFF's firm project database and included about 1 100 R&D performers in the period 1995-2002.⁸

The survey data revealed that FFF funding was generating various dimensions of behavioural additionality:

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7. Ireland also presented preliminary results of an evaluation at the project workshops. Although a summary chapter is not included in this volume, some key findings are included in the summary.
 8. Results of the econometric analysis were largely inconclusive due to the lack of appropriate measures of the benefits of behavioural additionality. A second problem was the limited availability of information needed for systematic evaluation. The latter problem could be addressed by increasing post-project reporting obligations on firms.

- Some 85% of the sample firms reported that they would have been unable to carry out their project without changes if they had not received FFF funding. Among firms that failed to receive a grant, approximately 30% cancelled the project and just under half continued, but with modifications.
- More than half of the firms indicated that without the FFF grant they would have taken more time to complete their project. About 60% of those that did not receive a grant did, in fact, see delays in implementation and a reduction in its scale.
- 45% of respondents indicated that their FFF-sponsored project represented a new effort that did not follow on directly from previous R&D efforts. In 63% of the firms the sponsored project enabled them to enter new research fields. In 43% of the firms, the sponsored project led to subsequent R&D.
- More than half the firms reported increased collaboration because of the FFF grant; half reported increased collaboration with public research organisations, and just over half reported increased collaboration with other firms.

The second Austrian study examined the *Kplus* competence centres, which are platforms for science-industry co-operation that focus on changing research culture by using public funding to help bring together researchers from the public and private sectors (see Chapter 4). The study was done in parallel with ongoing mid-term (fourth year) evaluations of the centres, but did not feed into the individual centre evaluations. Its purpose was twofold: 1) to assist the managing agency for *Kplus* (the FFG) in monitoring the impact of the *Kplus* programme; and 2) to provide useful information for the FFG, the *Kplus* centres and their partners to make decisions regarding their further development.

The study focused on participating firms and their research portfolios and adopted a before-and-after methodology: participating firms were asked to give information on the situation before the *Kplus* centre had started and on the situation four years later. A questionnaire was distributed to firms to inquire about their R&D, motivations for participating in the *Kplus* centre and other issues. Responses were received from 118 firms, representing 75% of all participating firms.

The main findings of the study include the following:

- One-third of the responding firms reported that they would not have carried out the project portfolio in the absence of the *Kplus* programme. Of the remaining firms, most would have realised the project portfolio, but with reduced scale, objectives or duration.
- Firms reported that the projects conducted in the *Kplus* competence centres are technologically more complex and longer term than those they conduct internally; participation also shortened the development time of important projects.
- Industry partners reported that participation in the programme enhanced their firms' reputation. The majority of firms expect positive effects on turnover, costs, and competitive position in the long term.

Belgium (Flanders)

Belgium (Flanders) examined behavioural additionality of R&D grants from the IWT-Flanders, the main support organisation for industrial R&D in Flanders. The research team developed a modular questionnaire that was customised for four distinct populations of firms: 1) large R&D-based firms, 2) large non-R&D based firms, 3) SMEs without perma-

nent R&D, and 4) high-tech SMEs. Surveys were performed via telephone interviews, but a set of preliminary interviews (intake talks) were conducted with the large R&D-based firms to better understand their innovation processes, decision processes for R&D projects, and management of government grants. These talks were seen as an essential part of the interview process and helped better target questions to the different respondents within each firm (see Chapter 5).

The study showed different decision processes and different impacts of government funding on the four different types of firms. For example, behavioural additionality at the project level was small for large R&D-intensive companies, which often apply for a government grant after deciding whether or not to proceed with an R&D project. Nevertheless, grants were found to have other significant effects, such as allowing R&D units to operate more independently of product divisions and increasing the scale or speed at which R&D projects were performed. For large companies without permanent R&D, subsidies were found to have significant behavioural effects, as such firms would conduct little R&D without state support. Subsidies have a strongly positive impact on SMEs, especially high-tech SMEs, for which government funding helped support their core activities. Their business strategy is often dependent on their ability to receive R&D support from the government.

Finland

The Finnish study (Chapter 6) aimed to evaluate the behavioural effects of R&D support from Tekes, the agency for innovation in Finland, but drawing on a number of previous studies that used a combination of interviews and surveys. In one of these, managerial responses to the additional effects of funding were explored. A questionnaire-based survey produced 193 responses from a sample of 645 firms that were randomly selected from a database of 15 641 firms. The survey revealed differences between recipients and non-recipients of Tekes funding, including the former group's larger size (in turnover and employment), lower profitability, higher exports and faster development. There was clear evidence that results from a funded project spill over into other parts of the firm, improving quality. Tekes funding is also reported to increase firms' credibility and hence their ability to form partnerships in clusters. At the core of the behavioural additionality issues, responses indicated that public funding affected the long-term business strategies of firms and allowed SMEs in particular to undertake longer-term and riskier projects. Funding also increased human capital and know-how.

A series of ongoing studies in Finland further explores the role of public funding. One is concerned with input additionality: the main goal of this study is to find out whether public and private R&D financing are substitutes or complements. The results suggest that public R&D financing does not crowd out privately financed R&D; instead, the analysis suggests that receiving public R&D funds increases opportunities for attracting private R&D financing. Another study compares applicants for Tekes funding with non-applicants. Even though members of the latter group perform R&D, applicants tend to be more R&D intensive. Applicants have often experienced considerable R&D intensity growth over the last three years and most applicants have introduced a product or process innovation during the last three years while the same is not true for the non-applicants. One piece of behavioural evidence is that the number of past applications has a strong decreasing effect on application costs. It also draws attention to the observed behaviour of the funding agency Tekes whereby firms that have more technologically challenging projects and SMEs receive higher percentage subsidies. Such differences may in turn influence firm behaviour.

Germany

The German study (Chapter 7) evaluates the behavioural additionality effects of public R&D funding provided via direct R&D project grants from the federal government. It is based on both results of the German Community Innovation Survey data from 2000 and 2003 (659 firms) and a telephone survey of firms that received public R&D funding for projects that were completed between July 2002 and August 2004. Over 200 telephone interviews were conducted, with a response rate of 39%. Findings in relation to behavioural additionality were derived from both descriptive and econometric analyses.

The descriptive analysis revealed that the effects of funding included:

- *Acceleration of R&D projects.* Almost 50% of companies sped up the launch of their R&D projects, and almost 30% of all firms reported that public R&D funds reduced the time taken to carry out the R&D project. Some 18% of all firms reported both effects.
- *Increased scale and complexity.* 55% of firms reported that public R&D support extended the size of their projects, and in 60% of the projects the technical challenge was increased.
- *Improved management.* Public funding of R&D projects also changed management processes for R&D. SMEs in particular benefited from higher flexibility to adapt their R&D management to the demands of the publicly funded R&D project.
- *Collaboration.* Almost 75% of the companies extended existing co-operation, both with scientific institutions and with other businesses in the funded project; 42% of the newly formed collaborations involved co-operation with scientific institutions; 58% involved industry collaboration.
- *Limitations to collaboration.* Of newly formed collaborations, only 25% of those with scientific institutions continued after the funded project came to completion, compared to just under half of those with industry. Of collaborations that had begun before the funded project, 80% continued after completion of the project, whether they involved partners from industry or the public sector.

These descriptive results were confirmed by a multi-variate analysis. From this econometric analysis based on the data from the Community Innovation Survey it was concluded that R&D funding is, in particular, a stimulating tool for the creation of R&D partnerships between the scientific community and industry. Publicly funded collaborative R&D is suitable for prompting firms to include scientific establishments as new partners in their existing business-to-business R&D collaborations. In this respect, *i.e.* in terms of stimulating new types of partnerships, public funding achieves its aim. However, *ex post* to public R&D funding it is also shown that newly initiated industry-science R&D co-operations are less likely to be continued after funding has ended compared to already existing co-operations. Overall, public funding tends to integrate the scientific community into business R&D partnerships, but these newly established networks are not necessarily lasting after funding has ended.

Ireland

In Ireland evaluations were made of two programmes, the R&D capability grants and the competitive RTDI schemes. Questions on behavioural additionality were incorporated into broader evaluations of these programmes. The approach was to create a database of company information, files, and forms for all of the companies that received funding. Interviews were carried out with 60 participating firms (less than 10% of total recipients) and 10 non-participating firms to solicit information regarding company experiences and views. The interviews were conducted at the level of the CEO or R&D manager.

The research showed that funded R&D was critical to the company in 64% of cases and very important in 31%. The funded project was not the only R&D project in a given year for 68% of the firms (implying that it was the only project in almost one-third of the firms), and other R&D projects accounted for over 20% of their R&D budget in 59% of the cases. For 61% of the firms, R&D expenditure was increasing over time. In terms of behavioural additionality, 82% reported that the project would have happened without support, but only 22% would have done it in full, while 40% would have progressed at a slower pace and 14% on a smaller scale.

A new issue that was explored in this study concerned location decisions, specifically whether the firm has been enabled by the R&D grant to locate or keep R&D facilities in Ireland. Two-thirds (65%) agreed with this proposition. Companies agreed that they were able to recruit higher skilled staff and to develop skills of existing staff. They also agreed that they had taken on higher risk R&D, and around half agreed that the projects had made them change their business strategy or their long-term manufacturing and business processes.

Japan

The Japanese study (Chapter 8) reviewed results of two recent efforts that provided useful insights into behavioural additionality. The first is the follow-up monitoring activity of the New Energy and Industrial Technology Development Organisation (NEDO), the agency that provides most of Japan's limited government funding of private sector R&D.⁹ The newly instituted monitoring system tracks the post-project activities of project participants and assesses the impact of national R&D projects. Information was available for 501 entities that participated in 56 R&D projects completed in fiscal years 2001 and 2002. The participating entities included 310 firms, 42 of which had brought their R&D projects to the point of commercial application, and were interviewed using a detailed questionnaire with approximately 90 questions categorised into four major areas: 1) details of the business; 2) utilisation of intellectual property; 3) spillover effects; and 4) NEDO's management and other issues. The expectations of monitored companies regarding NEDO's project were compared before, during and after the project. The second source of information was a survey of national project management conducted by Sakakibara *et al.* The survey aimed at collecting data related to participation in national programmes and focused on several topics, such as the objectives of participation, indirect effects of the programmes and the degree of networking and co-operation with other organisations. Around 1 900 firms received a questionnaire, and more than 500

9. About two-thirds of NEDO funding is spent on R&D projects, mostly through R&D consortia and individual firms in the form of contracted research.

firms responded within three months. Of these, 212 firms had participated in national R&D programmes.

The study found that NEDO projects had several behavioural effects on firms.

- *More challenging R&D.* Before participating in a NEDO project, firms expected that the project would most likely assist them in improving technology and/or product performance and in performing more challenging R&D. After project completion, they were most likely to report increased challenge as the primary benefit. The challenge of performing high-risk R&D was the most expected result of NEDO's project. From the simplified monitoring, 63% of the firms, representing 91% of monitored projects, were found to be conducting post-project activities, and related R&D projects had been launched in 29% of monitored companies.
- *Collaboration.* Participants reported that one of the most beneficial aspects of NEDO projects, seen during project implementation, was the formation of a network of personal contacts.
- *Organisational changes.* Some 37% of monitored companies had established a new organisational unit, such as a new R&D department, venture company, or joint venture, etc., after achieving practical application or commercialisation. Growth of the relevant R&D department occurred in 32% of monitored companies

The survey by Sakakibara *et al.* also indicates clear evidence of behavioural additionality. Seventy-six percent of responding firms reported that participating in government programmes was effective for training researchers, which could provide long-term benefits to the firm. Seventy-two percent of firms responded that government programmes had strengthened the technical base of the firms. Participating in government programmes was also helpful for improving corporate image in more than half of surveyed firms.

Korea

The Korean study used econometric techniques to investigate the effect of public R&D funding on overall levels of R&D performed in the business sectors (see Chapter 9). The model employed was based on a supply/demand type schedule, where marginal rate of return was plotted against the corresponding marginal cost curve. It allowed comparison of the effects of government funding of business R&D (*e.g.* via grants) and of government funding of public R&D (*e.g.* R&D performed in universities and government research institutes) on overall levels of business R&D spending. Effects could be measured over time to take into account lags between the time an intervention is made and its effects are seen.

The results indicated that public R&D funding has significant and positive effect on private R&D investment. They also indicated that long-term policies (*e.g.* funding public research organisations) is more important in stimulating private R&D investment than short-term policies, such as R&D grants to businesses. In the dynamic analysis, funding of public research organisations was found to have effects that endured up to 12 years, with peak effects at the ninth year after policy implementation. Direct government subsidies were found to have short-lived effects on levels of business R&D, dropping off quickly (*e.g.* within two years) after government funding is removed. This suggests that government grants did not induce recipients firms to maintain higher levels of R&D activity after the funded project came to an end.

Norway

A study by the Nordland Research Institute set out to assess how Innovation Norway's financial and professional involvement affects the financial and strategic development of companies which received grants or loans under ten different support schemes varying from R&D contracts to agricultural loans (see Chapter 10). It examined firms that received funding from Innovation Norway in 2000 and followed up on a preliminary survey that was conducted in 2001. The analysis was based on interviews with firms that responded to the 2001 survey and were still in operation. Some 36% of the more than 2 260 firms that participated in the preliminary survey participated in the follow-up analysis.

The study identified a number of effects of government support. The results indicate that 53% of firms would not have been able to realise their projects without public funding, while 16% would have realised them on a reduced scale or at a later time. Just over two-thirds of the companies reported that their projects contributed significantly to an increase in competence in one or more of their areas of expertise, most frequently in product development. More than 60% of firms experienced increased collaborative activity. Start-up businesses were shown to have maintained or increased their entrepreneurial orientation during the period of study, the latter characteristic being defined in terms of innovation, pro-activeness and readiness to assume risk.

United Kingdom

In the United Kingdom a small exploratory study on behavioural additionality looked at ten firms that had been supported by the SMART and LINK schemes (see Chapter 11). SMART supports near-market R&D projects by SMEs with fewer than 50 employees for feasibility studies and grants for firms with under 250 employees to undertake development projects to work up concepts to pre-production prototype stage. The scheme is now known as the Grant for Research and Development. LINK operates across government to support collaborative R&D projects between business and the research base. Previous evaluations of both programmes emphasised benefits in terms of capabilities and profile of the participating firms.

A particular interest in this study was to look at behavioural additionality in the context of a firm's total portfolio of interactions with the innovation support system over time and in parallel with the grant. Overall, the most important feature emerging from this aspect of the case studies is the cumulative learning involved in projects. While the award of individual grants could be justified in terms of a continuing need for resources either for the further development of the same innovations or for R&D aimed at different products, the attribution of benefits was less easy to distinguish across projects.

In particular, firms were insistent that even projects that had not led to exploitation, nonetheless contributed towards capabilities that were exploited in the context of other projects. These capabilities included:

- *Human resources:* people recruited as a result of one grant were subsequently key contributors to later work.
- *Technological knowledge and skills:* enhancements during one grant were applied in subsequent innovation activities.
- *Networking:* partners and contacts acquired as a result of one grant formed the basis of subsequent collaborations.

- *Reputational and prestige benefits*: accumulated through a track record of awards.
- *External knowledge absorption*: distinct from networking but often a consequence of it.
- *Using public support*: in the context of the critical role of public funding for R&D that was reported by these SMEs. It can be argued that an important dimension of learning is the ability to win initially and then to sustain public support through successive applications.
- *Improved innovation management capabilities*: developed through participation in the project.

United States

The evaluation of the United States' Advanced Technology Program (ATP) focuses on the relative success of joint R&D ventures formed as a result of the programme (see Chapter 12). Determinants of success were defined (*i.e.* technical objectives, commercial value, patents, trust, knowledge sharing, co-ordination costs), and a survey was conducted through the Web and by telephone. This approach allowed the researchers to achieve a high response rate of 81% of participating firms.

The survey showed that ATP played a critical role in stimulating co-operation and encouraging firms to pursue more challenging research agendas. Some 92% of respondents reported that they would not have formed their joint venture without the programme support. More than three-quarters of the projects reflected new directions for the firm, if not for the industry. ATP joint ventures were also found to be more ambitious and involved greater technological risk than other company R&D projects. One clear behavioural effect was that ATP was found to be fostering trust and co-operation among partners. Partners were shown to show goodwill and trust each other to a high extent, and a regression analysis showed ATP involvement to be an explanatory factor, along with effective governance procedures and the size of the joint venture. A post-project survey showed persistent collaborative links with 46% continuing to work with their partners on non-ATP technology and 14% with their sub-contractors. 55% continued in R&D because of their positive ATP experience. Strategic effects on behaviour emerged with 77% saying that their project reflected a new direction for their company and 83% saying that their project reflects a new R&D direction for their industry.

European Commission

The study of the European Commission (Chapter 13) consisted of a re-examination of the results of the Five-Year Assessment of the 5th Framework Programme (FP5) to identify behavioural additionality effects. The original evaluation was supported by several specific studies including a large scale survey in which questionnaires were circulated to around 12 000 participants of FP5 during 2004, with around 1 700 returned. The questionnaire was divided into two sections, an examination of the impacts on the organisation as a whole and an examination of specific impacts from participation in specific projects. Results were examined for applications that did not receive and FP5 award and those that did.

Overall, the survey indicated significant additionality effects of FP5, but only limited behavioural additionality in terms of influencing the nature of the R&D activity (*i.e.* technical choices). Rather, most projects were reported to be a continuation of existing project trajectories and portfolios. There was a significant impact on collaborative behaviour, in terms of goal attainment, impacts and formation of collaboration clubs. Among FP5 participants, more than 55% reported that they would not have undertaken the project in the absence of EU funding, even though 70% considered the projects to be of strategic importance for their organisation. While 36% of the remainder claimed that they would have gone ahead without FP5 funding, the failed applicant survey indicates that only 16% had gone ahead anyway. None of the failed applicants stated that they carried out the envisioned project with more international partners or with more partners in general after failing to receive an award, and half reported that project implementation slowed. Only a small portion of the rejected applicants who did carry out their projects stated that the objectives of their projects were less ambitious (6%) or that their expectations were lower (14%). Interestingly, 21% stated that the expectations of their projects, in terms of net benefits, were higher than anticipated. Also, 40% of the rejected applicants who nevertheless carried out their projects replaced the EU funds with internal funds, and 43% managed to carry out larger projects.

Toward a synthesis of results

The set of country studies provides a number of valuable lessons regarding both the types of behavioural changes that can be induced by government R&D funding and the ways of measuring them. As shown, the methodological approaches employed in the country studies rely heavily on surveys. This is not surprising given the economics of performing such studies: many companies can be surveyed at little cost. In some cases the data are also treated econometrically to explore particular issues in more detail but not all aspects of behavioural additionality are amenable to being modeled in a way suitable for such approaches. In general proxy variables need to be used. Variants include the use of a survey of rejected applicants and case studies. As the Belgian study highlighted, however, surveys can be more productive if linked to more in-depth interviews that allow surveys to be tailored to different populations of firms that use government R&D support in different ways. Hence, a comprehensive approach to measuring behavioural additionality would entail multiple instruments used either in sequence or simultaneously to provide broad coverage of a large number of firms, as well as more detailed, company-specific insight.

In terms of the types of behavioural additionality seen in the programmes studied, they ranged from short-term influences on decisions to initiate a particular project, to changes in the type of R&D conducted and the way in which it was conducted, to changes in firms' ability to manage and conduct future R&D projects. Many of the country studies were designed before the OECD project began and hence the methodologies are not sufficiently consistent to allow a direct combination of data. Nevertheless, sample sizes were quite large, meaning that a substantial body of evidence was collected and some general comparisons may be made. Classifying different behavioural effects in a common format that differentiates between behavioural changes seen during the implementation of a government-funded project and after the completion of a project helps distinguish among effects on different aspects of company behaviour (Tables 1.3 and 1.4):

- Behavioural changes during project implementation:
 - *Decisions regarding project launch:* in many cases, decision whether or not to launch a particular project was influenced by the availability of government funding. Many project were done only because of government support. A lack of government support did not necessarily mean cancellation of a project, but more generally resulted in a reduction in the scale or scope of a project (project additionality)
 - *Acceleration of projects:* government support enables firms to accelerate implementation of their project (acceleration additionality) by providing more resources. This can be important in enabling a firm to move ahead of its competition and enter markets more quickly.
 - *Expanded scale and scope:* government support allows an expansion of the scale of projects or types of partnerships involved (scope and scale additionality). Many projects involved collaboration with partners in the public or private sectors, facilitating access to a broader range of knowledge.
 - *More challenging research:* government support encourages firms to take on more challenging R&D projects (challenge additionality), which can help them develop new competencies that can be exploited in future innovation efforts.
- Behavioural changes after project completion:
 - *More collaboration:* government support results in greater co-operation and networking among firms (network additionality). In one-half to two-thirds of the projects, new collaborations were formed. As the German study illustrates, the continuation of collaboration after the project cannot be assured.
 - *Project follow-up:* between half and two-thirds of firms reported that they pursued additional projects that followed-up on government-supported R&D (follow-up additionality). In such cases, the government-funded programme enables a firm to develop a capability that it exploits in further R&D.
 - *Improved management:* many firms reported that company management routines were improved as a result of participation in a government-funded project (management additionality). These changes could result in further participation in government programmes, changes in organisational structures for conducting R&D or commercialising results, and different management strategies.

Because of different definitions in the studies these categories may overlap, with some findings potentially reportable under more than one category. Clearly, increased collaboration is a behavioural change that can take place during or after a project. The most interesting cases, however, are those in which collaboration continues after completion of the project. Furthermore, the absence of a reported effect does not mean that it did not occur, only that it was not reported in the papers or presentations received.

Table 1.3. Behavioural additionality *during* the project: summary of findings

Country	Type of behavioural additionality (Anticipated effect of failure to receive government funding) ¹			
	Project launch	Accelerated schedule	Expanded scale & scope	More challenging research
Australia (R&D Start)	37% would have cancelled.	100% would have taken longer.	92% would have scaled down.	78% would have been less challenging. 64% would have reduced range of applications.
Austria (FFF)	28% would have cancelled (31% <i>did</i> cancel). 61% would have sought alternative funds (25% <i>did</i> seek alternative funds).	32% would have postponed (43% <i>did</i> postpone). 51% would have taken longer (61% <i>did</i> take longer).	74% would have scaled down (60% <i>did</i> scale down).	49% would have been less challenging (40% <i>were</i> less challenging).
Austria (Kplus)	33% would have cancelled.	Firms would have slowed down implementation.	67% would have carried out project with limitations.	Firms would have reduced the technical challenge.
Finland	20% would have cancelled.	-	46% would have scaled down.	48% of projects were too risky to carry out alone. 73% would have reduced technical ambition.
Germany	-	With government funding, 53% sped up project launch; 28% sped up project implementation.	With government funding, 55% extended project size.	With government funding, 60% pursued more technically challenging projects.
Norway	53% would have cancelled.	16% would have slowed the R&D.	-	-
United States (Advanced Technology Program)	93% would have cancelled.	-	-	82% of funded projects were more ambitious than firms' typical R&D projects, and 70% were more technically challenging.
EU (5 th Framework Programme)	57% would have cancelled.	33% would have taken longer.	76% would have scaled down.	43% would have been less challenging.

Table 1.4. **Behavioural additionality *after* the project: summary of findings**

Country	Type of behavioural additionality (Reported impact of participating in the government programme)		
	More collaboration	Project follow-up	Improved management
Australia	67% formed new collaboration with another company. 48% formed new collaboration with universities or research institutes	87% participated in subsequent government programmes.	70% introduced entrenched changes in R&D management. 60% enhanced their commitment to R&D. 56% improved their understanding of benefits of R&D. 50% changed commercial strategy.
Austria (FFF)	51%/55% collaborated with public research organisations/other firms.	43% resulted in subsequent activities. 63% extended R&D into new areas.	-
Austria (Kplus)	Firms recognised collaboration more important.	50% resulted in subsequent activities.	78% sell on international market. Share of R&D funding spent externally doubled in four-year period. Larger share of participants engaged in EU-funded programmes.
Finland	53% strengthened collaborative networks. 50% collaborated with research institutes. 35% increased subcontracting.	-	44% affected long-term business strategies. 53% doing R&D not connected to short-term business strategy.
Germany	78%/74% intensified collaboration with research institutes/industry. 42%/58% formed new collaboration with research institutes/industry.	... but new networks do not necessarily last long after funding has ended.	66% changed R&D management as a result of public funding procedures
Japan	-	63% resulted in subsequent activities. 29% established related projects. 21% of projects reached the stage of commercial application.	32% expanded R&D department.
Norway	60% increased collaboration.	-	67% increased competence, usually in product development.
United States	More than 90% of joint ventures would not have formed without ATP support. 64% indicated that programme fostered increased trust and cooperation among partners.	-	
EU	70% reported increased collaboration.	-	-

Conclusions

Influence on policy and practice

The sense emerging from the national studies and recent policy documents is that the behavioural additionality concept provides policy makers with a useful vocabulary for evaluation. It can help explain that the effects of policy interventions may be greater than those perceived through a narrower input-output lens, and that the range of effects and the means by which they are achieved are complex mechanisms requiring substantial effort for successful policy design.

In terms of practical application, the behavioural additionality rationale is coming into use. For example the European Commission's *ex ante* assessment of the Seventh Framework Programme uses behavioural additionality to describe the catalyst effects of public support. In the United States, the US Advanced Technology Program states that capturing this knowledge creation and change in behaviour and whether these changes persist is important for understanding the impact of ATP-funded project, and that participating in the OECD workshops on behavioural additionality has provided ATP with new insights and approaches which will enhance and inform survey design and future work (Shipp *et al.*, 2005). From Japan it is argued that using input additionality indicators and short-term output additionality indicators exclusively can induce attitudes that prefer low-risk short-range oriented research agendas. Behavioural additionality indicators are seen as having the potential to rectify these shortcomings and the possibility of revising the National Guidelines for Evaluation to incorporate the concept has been raised. All of the national studies contained in this report indicate some utility for future programme and evaluation design.

Policy implications

Both from the theoretical perspective and from the collective findings presented here, it is clear that a better understanding is needed of the way in which support interacts with and affects the strategies of firms. Many policymakers have arrived at successful scheme designs through insight or through trial and error but not, one can argue, through a clear understanding of these interactions. Sometimes the necessary obligations of public accountability can obscure the picture: it is much easier to account for a single project with defined deliverables (usually artefacts) than it is to argue for supporting and influencing a part of a larger and ongoing effort, or for a result that is more significant in its behavioural influences. It is even less easy to design policies in the expectation that the effects will be cumulative across support measures (so-called policy-mix for innovation) or longitudinally over a succession of grants. Nevertheless, these issues need to be confronted, not least in the way that such interventions are evaluated. Ultimately they suggest a systemic approach to policy making which is nonetheless flexible enough to adapt and learn.

Some of the effects emerging are double-edged. On the one hand it is beneficial to help firms make efficient use of public support through learning how to seek out and apply for opportunities. On the other hand there is a risk that these will crowd out equally eligible applicants who lack such skills. One conclusion could be the need for a scheme targeted at new entrants, analogous to those operated for young researchers in the scientific domain.

Once behavioural effects are clearly identified, policy makers may enter debates about how desirable the effects are, and to what extent. For example, how much effort in networking is optimum for a firm in particular circumstances? Also, a metric of behavioural effects could be sought. Is it the case that the bigger the grant, the bigger the effect? This is simply not known. An alternative postulation is that a clear benefit from change illustrated by a single intervention, or a series of them, could be recognised by the firm and embodied into its broader routines.

Conceptual base

This report takes a first step to reconcile the behavioural additionality concept with the dynamic capabilities management literature which is also interested in the teams, partnerships and innovation management routines that we might expect public support to impact upon. The value innovation perspective also shows the potential importance of induced strategic shifts that might lead to new markets. More closely within the field of innovation studies, there is the contention that behavioural additionality is bridging the neo-classical approach with the systemic approach by evaluating the difference in behaviour on the firm level due to government financial support has gained support.

In constructing rationales for public intervention, recognition of behavioural effects means that the argument that a simple fiscal incentive (or cut in tax) achieves the same effects as grants in a more efficient manner is not sustainable. Fiscal measures can also achieve behavioural additionality but only when they are targeted, *e.g.* on the acquisition of R&D staff. Grants are a much more subtle instrument and carry with them both the potential to lead firms in positive directions and the risk of giving complicated signals. This work also brings into scope some key factors that normally remain neglected in the background. The delivery mechanism for grants and the contacts between the agency and firms are as much a part of the effects as is the finance itself. Countries working with a system of innovation rationale can also see more easily a route to addressing perceived system failures.

Measurement issues

While case studies remain the favoured method in this exploratory stage, much of the evidence comes from surveys of programme participants – indeed as a meta-survey this project has amassed a body of data worthy of analysis in its own right. One problem with survey approaches is that they present firms with a menu of effects that may in the end be limiting. Within these studies the Irish finding of effects on location decisions and the UK incidence of cumulative reputational and prestige effects were both issues not frequently pursued in evaluations. A continuing aim is to compile a comprehensive taxonomy of behaviours.

The issue of cumulative effects points towards the use of panel studies with the firm as the unit of analysis. However, instituting these requires an act of political will and an acceptance that accurate results may take years rather than the three months typically allocated to a routine evaluation. This could examine the characteristics of firms that make them more or less amenable to behavioural influences. An instrument precise enough to work through the effects of each point of the funding cycle would also be beneficial if the role of selection, contracts and monitoring is to be understood. The assessment of long-term learning and persistence of effects is crucial. The issue of a control group remains difficult particularly in a transnational context.

It is also possible that certain behavioural traits, in any size of firm, could be specific to the situation of public funding and not penetrate to self-funded activities. Hence, a logical extension of this work would be a systematic comparison of the full behavioural context between publicly funded and self-funded R&D and innovation in the same firm. More generally an understanding is needed of the characteristics of firms that make them more or less amenable to influences upon their behaviour.

In methodological terms the next step from this collation of disparate activities would be for a deliberate use of a common core of questions and broader methodological approach across several nations and programmes. This would allow a critical mass of data which could be used to underpin a more rigorous analysis of this phenomenon.

Final comment

A final caution is that behavioural effects may not always be positive and hence that evaluators should be prepared also to recognise negative behavioural effects. These could include influencing firms to undertake R&D that is inappropriate – for example too long-term given their financial position, or causing projects to become too complex because of the imposition of redundant obligations to collaborate. In the final balance, these should be offset against the undoubtedly undervalued influences of government R&D support which have been exposed by this study. It is also important to bring effects currently thought of as unintentional into the scope of the instruments in question. In making future choices policy makers should be aware that the R&D grant mechanism studied here is potentially a much more powerful tool than one which merely corrects perceived deficiencies in available finance.

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Chapter 2

BEHAVIOURAL ADDITIONALITY OF BUSINESS R&D GRANT PROGRAMMES IN AUSTRALIA

Prepared by the Department of Industry, Tourism and Resources of Australia

Abstract. This report presents the findings of a study which was undertaken to identify the impact of the grants received under the R&D Start programme on firm behaviour. The study builds on a pilot survey targeting companies which had completed an R&D Start grant, and included both qualitative and quantitative elements. The receipt of an R&D Start grant was found to have induced behavioural changes in all of the firms which participated in the study, although the nature and degree of change varied. The most marked changes in firm behaviour attributed to the grant were: 1) an increased commitment to R&D, 2) an increased understanding of the benefits of R&D, 3) generation of and/or entrenched change in project management, 4) formation of new collaboration with companies which is expected to continue, and 5) encouraged firms to apply for other forms of government assistance. The survey found that 63% of respondents would have continued with the same project had government funding not been provided. However, for all of these firms, the project would have taken longer. In the majority of cases, it would also have been undertaken with a smaller budget, on a smaller scale and/or with less ambitious outcomes. For the 37% of projects that would not have proceeded, lack of funding was the key reason. R&D is a core activity for 95% of firms, and underpins their need to develop new products, stay at the leading edge of their industry, maintain their business in a rapidly changing environment, and increase profits. Future work will entail asking the same set of questions of 100 firms receiving an entitlement-based R&D tax concession. A comparative analysis of the changes in behaviour resulting from grants-based and entitlement-based support will be completed.

Introduction

Australia has in place a range of programmes to support business investment in research and development and other innovation-related activities which, collectively, aim to improve industry competitiveness, enhance productivity and ensure the introduction of innovative new products, processes and services to the market. This support comprises both competitive grants programmes and an entitlement-based R&D tax concession. Programmes are generally available to all industries, although a number are targeted at market failures which are unique to particular sectors.

The ability to accurately evaluate these programmes is critical to determining their effectiveness and efficiency, and ensuring that they continue to meet their policy objectives. The Australian government has in place a series of measures and indicators to evaluate the inputs to R&D and innovation and, to a lesser extent, the outcomes and outputs. There is, however, scope to build on the identification and measurement of benefits arising out of a grant, particularly those resulting from changes in behaviour, and this underpins much interest in the international work being done on output and behavioural additionality.

There is considerable anecdotal evidence about the impact of a grant on firm behaviour, including changes in culture and attitude, but there are few methodologies to measure both the nature and impact of such changes. The study seeks to identify indicators of behavioural additionality and to develop some mechanisms to measure such changes.

In undertaking the study, we sought to determine whether grants were: 1) supporting research projects that would otherwise not proceed; 2) broadening the scope and reducing the time taken to complete the project; and 3) influencing attitudes about the importance of R&D, business practices (including levels of collaboration) and business strategy.

Survey participants all received grant funding under the R&D Start programme. The R&D Start programme was established in 1996 and closed in September 2004. Over this period, it provided USD 1.01 billion in grants to 1 134 companies.

R&D Start is a competitive programme which provided grants of up to USD 15 million for businesses to undertake research and development, and some aspects of the commercialisation of its outcomes. Firms seeking to participate in the programme submitted a detailed application addressing a series of merit criteria. Successful firms entered into a contract with the Commonwealth and were required to report regularly on milestones and outcomes. The reporting regime extends for five years after the final payment of grant monies. Although the programme has closed to new entrants, many firms are still receiving R&D Start grants or are in the post-project reporting phase.

R&D Start has been replaced by the Commercial Ready programme, a competitive merit-based grant programme supporting innovation and its commercialisation. Commercial Ready aims to stimulate greater innovation and productivity growth in the private sector by providing around USD 200 million per year in competitive grants to small and medium-sized businesses (SMEs) between 2004-05 and 2010-11. Support is provided for R&D, proof-of-concept and early stage commercialisation activities.

Framework for the study

The field of behavioural additionality has grown out of the understanding that grant programmes affect a range of firm behaviours that contribute to the firm acquiring new attitudes, skills and capabilities.

The study drew upon the definitions of behavioural additionality proposed by Luke Georghiou (2004) as “the difference in firm behaviour resulting from the intervention. The assumption is that the behaviour is changed in a desirable direction, though an evaluation should also be sensitive to perverse effects, for example encouraging firms to take risks that they cannot afford”. It also drew on the work of Georg Licht (2003), who defined the term as “changes in the behaviour of firms inducing a more efficient transformation of innovation inputs to innovation outputs; these changes should be permanent in character (*e.g.* collaboration)”.

The need for policy makers to understand, and exploit, the occurrence of behavioural additionality is clear. Davenport and Grimes (1998) argue that “policy administrators can exploit the occurrence of behavioural additionality to maximise the impact of research policy, on the basis that modified behaviour is likely to strengthen a policy’s latent ability to influence the creation of output additionality”. And, as Georghiou (2004) points out, “while input and output additionality operate at a point in time, behavioural additionality effects may be expected to endure beyond the period of the R&D and to be integrated into the general capabilities of the firm”.

In the Australian context, behavioural additionality has been interpreted as meaning persistent changes in firm attitude, culture or behaviour that resulted from participation in a grant process. This has led to a survey approach that combines quantitative and qualitative aspects to enable changes to be measured and to investigate the reasons for these changes.

In developing the questions, consideration was given to the types of behavioural changes which are most likely to be induced by the R&D Start programme’s requirement to match grant funding, use of the competitive application process and legal requirement for regular reporting against agreed milestones. Taking into account the characteristics of the R&D Start programme and previous studies in the field, questions address the degree of full input additionality, identify whether the grant impacted on the timing, scale or scope of the project, and investigate changes in management behaviour including changes in attitude to R&D, changes in project management and the extent of collaboration.

The Australian survey questions drew on the work of Georghiou (2004), which suggests that questions might explore whether support has assisted the firm to acquire “new competencies, ranging from project management skills, through various technological and market routines and capabilities...”.

Clarysse *et al.* (2004) discussed the design of behavioural additionality questionnaires, sample selection, interview methods and included a model survey tested on 25 firms. This was used as a basis for the Australian study of R&D Start participants. The framework of Clarysse *et al.* (2004) classifies questions according to behavioural, input and output additionality, and defines behavioural additionality questions as being strategic or operational, as well as at the project or company level. This approach is well aligned to the R&D Start programme, given that it funds a particular project undertaken by a company and that the questions developed by Clarysse *et al.* include aspects of behaviour that the R&D Start programme was expected to have affected.

Survey methodology

Population and approach

This study combines data from 24 firms interviewed in our pilot survey with data from an additional 76 firms to give a total population of 100 firms. All firms interviewed had completed an R&D project which was supported by the R&D Start grant.

Our sample of 100 firms represents around 9% of all firms which received funding under the R&D Start programme. We sought to make the sample as representative as possible of the total population of firms receiving R&D Start grants, and the selection of firms was guided by the need to balance the key variables of business size, industry sector and geography (state or territory of head office). A three-year average, spanning the main application period of the survey population, was used as the comparator for the sample

population. The survey population matches the sample population within $\pm$ five percentage points across all seven turnover categories, 12 of 13 industry sector categories and for six of seven geographic categories (Annex 2.2 gives details).

The questions were asked in face-to-face or telephone interviews with senior executives from the firms. A qualitative and quantitative approach to the study was adopted to gain statistically comparable data about outcomes. The qualitative aspect of the study adds depth to the responses, facilitated further probing of participants and allowed unanticipated factors to emerge.

Questionnaire design

The questionnaire commenced by asking whether the project would have proceeded without grant funding in order to measure the extent of input additionality of the R&D Start programme. This question also provided a context for questions on the effects of the absence of grant funding, which were asked of those firms which advised that the project would have proceeded without grant funding.

The subsequent group of questions sought to determine the degree of behavioural additionality at company level induced by the grants, focusing on cultural attitudes, project and business management, and the development of external collaborative relationships. These questions also asked whether receiving an R&D Start grant had encouraged the firm to apply for other government grants. Whilst this question was classified as an impact on input by Clarysse *et al.* (2004), it is included in this study on the basis that firm willingness to explore other grants is a measure of increased awareness of the benefits of R&D and an increased commitment to R&D in the company.

The final question sought to determine whether the R&D activity was a core element of the business' operation, or a one-off activity. It was included to gain further insight into the way in which the grant had changed attitudes and influenced ongoing behaviour.

Participants indicated their responses to statements about changes in behaviour using a Likert scale. The data is reported as the percentage of participants who disagreed (disagree or strongly disagree), were neutral or agreed (agree or strongly agree) with each statement in the questionnaire. Compared with averaging scores, this approach conveys more information, especially in situations where an average score was simply the middle point between two sets of polarised views.

Survey results

Key messages

Sixty-three percent of the surveyed firms suggested that the project would have proceeded in the absence of government funding. Of those, the majority (between 78% and 100%) indicated that the lack of support would have had resulted in a project that was slower, less well funded and with reduced outcomes. The need to get high quality innovative products to market quickly is critical to the competitiveness and growth of Australian industry. As such, the R&D Start grant has a clear and positive impact, even on projects which would have proceeded in the absence of grant funding.

The majority of firms indicated that receipt of R&D Start funding has had an impact on their behaviour, although the extent and type of impact varies quite considerably. For 87% of firms, experience with the R&D Start programme has encouraged them to apply for other forms of Government assistance. Receipt of the grant resulted in entrenched

changes to the way in which 70% of firms manage their projects. The grant had resulted in an enhanced commitment to R&D in 60% of firms and a stronger understanding of the benefits of R&D in 56% of firms.

Commercialisation and business strategies were less affected by the grant, with 50% and 51% respectively agreeing that the grant had changed these behaviours. This result is consistent with the fact that the R&D Start programme assists companies to undertake research and early-stage commercialisation of technological innovation and is not primarily focused on changing business or commercialisation strategies. It also reflects the fact that many firms have sound business and commercialisation strategies in place, and are drawing on these to support their R&D and commercialisation activities.

The behaviour least changed by the grant was the formation of ongoing relationships with universities or public laboratories. Comments indicate that this was largely due to the companies having existing relationships prior to the grant or, in a smaller number of cases, the nature of the work precluded such collaboration.

Detailed analysis

Impact of the grant on the project

When asked, 37% of respondents indicated that they would not have proceeded with the project in any form had they not received grant funding (Table 2.1), demonstrating the importance of funding support (including by government) in company decisions about whether to undertake a research project. This finding is also indicative of the high cost and high risk of R&D and the attractiveness to many firms of having a partner to share this risk.

Table 2.1. Expected project outcome without grant funding

Expected outcome	Percentage
Continue project	63
Discontinue project	37
Total	100

The finding that 37% of projects would not have proceeded in the absence of grant funding is comparable with a range of other international studies, most notably <50% by Buisseret *et al.* (1995), 41% by Shipp (2004) and 37.5% by Davenport *et al.* (1998). It is higher than the results reported by Falk (2004) at 31% and Clarysse *et al.* (2004) at 29%.

The key reason cited by business for not proceeding with the project in the absence of a grant was that the firm lacked the necessary funding. In the discussion on this question, respondents indicated that they could not have funded the R&D project from revenue or from investors. According to one company, the R&D was very “bold” and high risk, and could not have been funded solely from internal resources. Other companies confirmed the disincentive posed by the high risk of R&D, noting that investors are traditionally cautious about research. Some firms indicated that internal funding was the only option they considered to finance the project and that cash constraints either prevented the project from going ahead or substantially reduced its scope.

The decision not to go ahead with a project did not suggest that the project had a low priority, rather the decision not to proceed was the consequence of funding constraints. In one case, the firm stated that the project would not have gone ahead without the grant, even though “R&D is core to the business”. Another company reported that a project, which would have been discontinued without the grant, delivered a breakthrough result. Grant funding has also, in some cases, been critical to the survival of firms, with one participant stating that it “would not be here today except for a number of grants along the way”.

In a number of cases, the firms used the grant to finance projects that were well outside of the normal scope of their R&D. For these firms, the grant did not just make a marginal project more viable, it also facilitated projects that were a quantum level above the firm’s normal R&D in both cost and complexity. These firms often reported a significant impact from the grant in behavioural change, as well as sales and staff levels. Such projects are pivotal in the development of the firm and mark a major turning point in business culture, business volume and may result in the firm moving into wholly different market segments. One firm indicated that the project supported by R&D Start had taken it from a State based business to an international company, had changed its basis of operations and had changed the industry sector that it operated in, as well as impacted strongly on the surveyed aspects of firm behaviour.

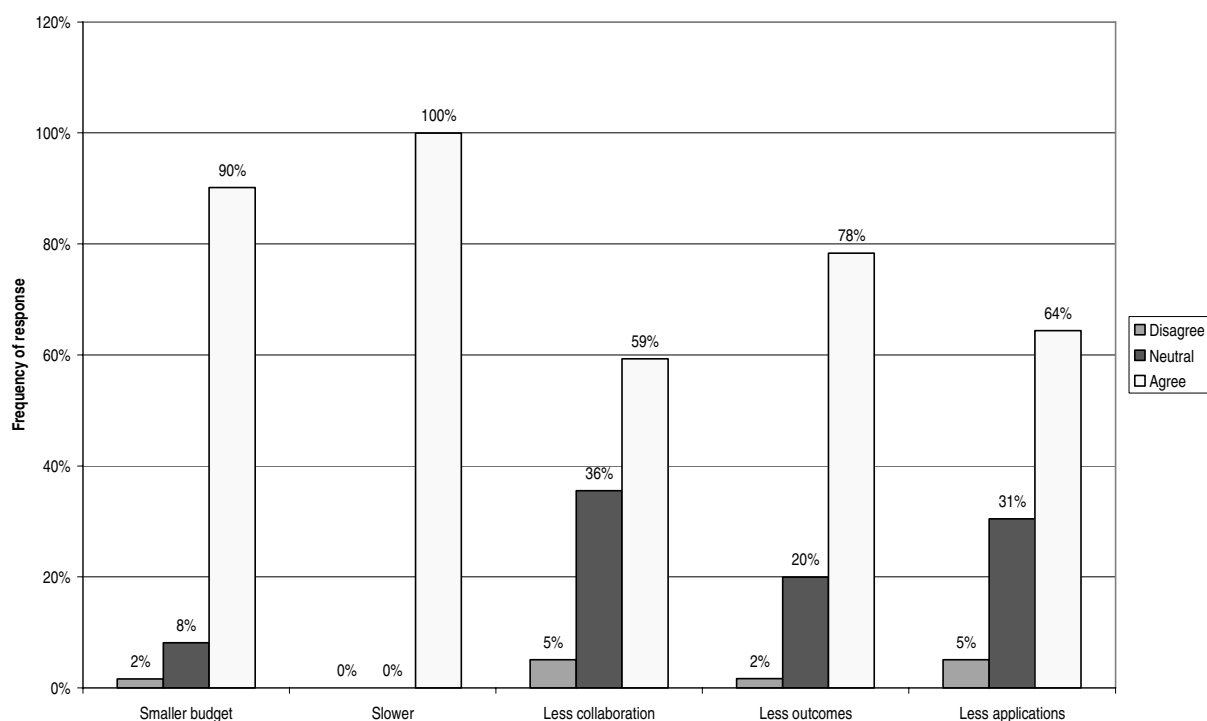
In the absence of grant funding, small firms (less than 20 employees) were much less likely to proceed with the project than medium sized firms (20 to 199 employees). Small firms accounted for 57% of the survey population, and 73% of those firms indicated that the project would not have proceeded without the R&D Start grant. Medium firms represented 43% of the survey population, yet only 27% indicated that they would not proceed in the absence of the grant. Thus, there appears to be some relationship between firm size and capacity to independently fund R&D and absorb any associated risk.

Sixty-three percent of companies reported that they would have proceeded with the project in the absence of grant funding. These companies were asked about the expected impact on the project had the grant not been awarded. Figure 2.1 presents the data graphically while Annex 2.3 presents consolidated survey data.

Whilst these projects would have proceeded, they would, for most firms, have been at a slower pace, with less funding and with fewer applications. This has significant implications for business and the economy more broadly, given that the need to get innovative new products, processes and services to market quickly underpins the competitiveness, productivity and growth of Australian firms.

All firms indicated that, in the absence of grant funding, the project would have proceeded at a slower pace. Ninety-two percent of projects would have proceeded with a smaller budget, 78% would have less ambitious outcomes and 64% would have had a reduced range of applications. Consistent with the previous question, firms suggested that the critical importance of grants was to supplement their own funds where they were insufficient to support R&D costs and to share the high-risk associated with the R&D.

Figure 2.1. Predicted effects of continuing the project without grant funding



Small businesses were more likely than medium businesses to agree strongly that the project would have proceeded more slowly in the absence of grant funding (76% of small firms compared to 56% of medium sized firms). Medium businesses, however, were more likely to agree or agree strongly (97%) that the project would have proceeded with a smaller budget than small businesses (83%). Discussion suggested that small businesses tend to cost project proposals on the basis of minimum expenditure that could return a viable product. There is thus no option for further cost reductions in these firms.

Smaller project budgets would have had a number of flow-on effects for the project. Firms indicated, for example, that they would not have been able to hire specialist R&D staff or consultants necessary to “make the product world class” or to “offer a well designed and finished product”. Reduced funding would also have “made it hard to achieve critical mass in the R&D team” or to “separate the R&D team from day-to-day work”.

Collaboration was the factor least affected by lack of grant funding, with 59% of respondents agreeing that collaboration would have been reduced. Discussion with firms suggested that collaboration is less likely to be affected by reduced funding for three reasons:

- Many firms do not collaborate for strategic business reasons including that they have all necessary skill within the firm.
- Some forms of collaboration are not costly, for example with suppliers, customers or firms that cross license IP.
- Collaboration supplies essential products or services that the firm cannot produce internally and which are critical to the project. Thus collaboration could not be reduced if the project was to remain viable.

Firms indicated that they may not have all the skills needed to take a product to market and relied on other organisations to complete aspects of a project. This was particularly true for the biotechnology and medical sectors, which need access to specialised skills to meet regulatory and licensing requirements.

In discussing the effect of grant funding and its impact on the project, a number of companies noted that, due to the competitive nature of grant funding, it substantially enhanced their credibility within the industry and with funding organisations (often referred to as the ‘halo effect’). Firms also reported that the credibility associated with success in this competitive grant programme has assisted in gaining venture capital, engaging contractors, forming relationships with academics and particularly in gaining entrée to potential large customers or distributors. This was particularly true for small and/or new firms.

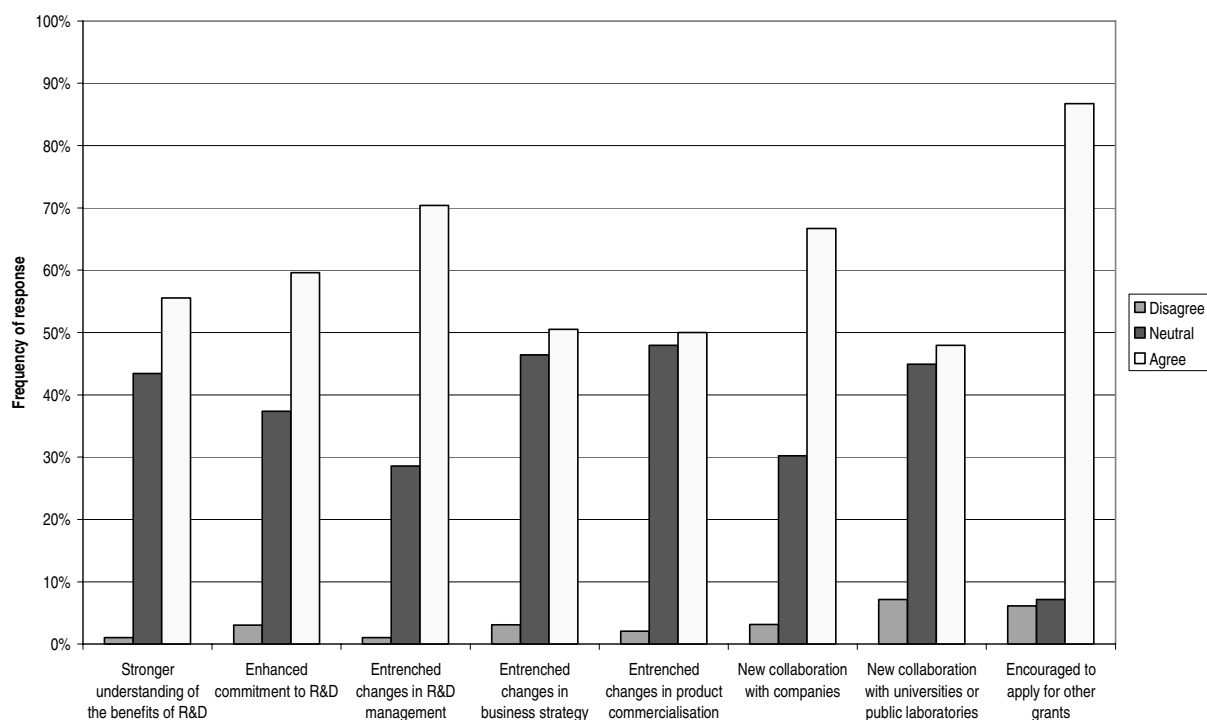
Impact of the grant on behaviour

Participants were asked about the impact of the project funded by R&D Start on a range of identified behaviours. Participants were asked to agree or disagree with a number of statements, which were worded to avoid measuring transitory effects, for example the term ‘entrenched changes’ was used rather than ‘changes’.

Figure 2.2 presents the data from this question graphically while Annex 2.3 provides consolidated survey data. The most significant impact of the grant was to encourage firms to apply for other forms of government assistance, with 87% of respondents confirming this as a consequence of receiving a R&D Start grant. For many respondents, receiving an R&D Start grant gave them experience in preparing applications, monitoring expenditure and reporting on outcomes. Firms commented that they were able to build on the experience and confidence gained through successfully accessing R&D Start. In other cases, simply approaching government for support created a greater awareness about the programmes which might be available to them.

Six percent of participants did not agree that the R&D Start grant encouraged them to apply for other government assistance. Firms indicated that this was due to a number of reasons, including that compliance costs were perceived to outweigh the benefits or because the definitions of eligible activities for other programmes precluded some of their key research activities.

Figure 2.2. Impact of the grant on listed behaviours



A second key change in behaviour generated by the grant was to entrench changes in the way the firm manages its R&D, with 70% of participants confirming this as an outcome. The number of firms disagreeing with this statement was equal lowest across the survey at 1%.

In discussion, participants noted that the grant had required them to revise their systems and upgrade their project management skills. Many firms echoed the comment of one survey respondent that “we created new project management tools for the Start project and transferred these tools to other projects”. One firm noted that the grant’s reporting requirements had “forced more rigour in accounting, reporting and stronger governance” and said that this had been of “strong benefit” to the company. A second firm advised that “R&D Start reporting requirements greatly increased our reporting standards and management control and we have incorporated all these changes”. Others cited changes in personnel management practices, development of and reporting against milestones, and improved project budgeting systems.

The vast majority of the 29% who reported that the grant caused no change to their R&D management said that they already had strong project management systems in place. Most of these firms were from the medical and biotechnology sectors, and already had implemented systems to meet regulatory and licensing requirements. Similarly some manufacturing firms already had ISO9001 compliance regimens in place. Other firms noted that the requirements of venture capitalists had caused them to put R&D management systems in place prior to the grant application.

Sixty-seven percent of the respondents agreed that the grant had resulted in new collaboration with other companies that was expected to continue. Comments suggest that this collaboration is with consultants, firms supplying products or services to support the research, customers or partners in a strategic alliance. Participants noted that the grant fostered collaboration by:

- Consolidating relationships with contractors.
- Facilitating partnerships with overseas companies.
- Fostering relationships with suppliers as companies sought new materials and components for their new product.
- Attracting business partners due to the well planned R&D programme.
- Increasing the firm's profile – the R&D Start project won one firm an international award and resulted numerous business inquiries.

Thirty percent of companies reported that the grant did not change the extent of their collaboration with other firms. These were largely firms that do not collaborate due to the nature of their work.

Forty-eight percent of participants reported that the grant had encouraged new collaboration with universities and public research institutions that is expected to continue. According to one firm, receipt of the grant was the “catalyst for collaboration”. Some have used the university as a source of contract R&D or utilised sophisticated testing facilities. Others have formed strong formal links with research institutions and either have personnel doing higher degrees relevant to company R&D or host PhD students. One theme that emerged through a number of the interviews was that the grant enabled companies to work with world leaders and that it could not have afforded to do this without the grant.

Forty-five percent of companies reported that the grant did not change their level of collaboration with universities or public research institutions. Of those that commented, frequent reasons were that the firm was already collaborating prior to the grant and that the nature of the R&D was not appropriate for collaboration. A number of firms advised that previous negative experiences discouraged further collaboration.

Fifty-six percent of firms agreed that the grant had given them a stronger understanding of the benefits of R&D, while 43% said that it caused no change. This result needs to be viewed in context of the 95% of surveyed firms that reported R&D as a core activity over the last few years. Taking this into account, it is not surprising that a large number did not increase their perceptions about the importance of R&D, given that they were already highly focussed on R&D.

The more interesting question is why the grant increased understanding of the benefits of R&D in firms already performing R&D. The explanation may lie in the fact that, although many of the companies perform R&D as a core activity, the R&D Start grant allows them to take on substantially bigger projects than they could otherwise fund themselves. These larger projects may introduce a number of different aspects of R&D, for example the use of consultants, more complex project planning, more rigorous R&D management and more ambitious R&D goals. This explanation is consistent with comments made during the interviews that the grant enabled the company to take on a significantly larger and more complex project than had been attempted before.

The ways in which the grant increased firm understanding of the benefits from R&D came from a number of points in the grant process. Preparing the grant application caused some firms to plan or evaluate the project more closely than it might previously have done. One firm stated that it was “long, detailed and eye-opening as to the cost (of R&D).” This firm also said that the “process was enormously time-consuming but well worth it”. Another firm noted that the investment in planning helps later commercialisation as “well documented R&D helps commercialisation”. A number found that performing the project increased their understanding of the benefits of R&D, with one firm noting that “it needed to do a large R&D project to fully understand the benefit to the company”.

The grant also assisted companies to realise that a key positive outcome of R&D was an enhanced innovative culture in the company. Participants noted, for example, that “successful project increased firm's perception of the importance of R&D”, “grants influenced all employees within company” and “the grant moved R&D from vision of senior management to whole-of-company vision”. Some firms found the projects supported by R&D Start to be fundamental in establishing an understanding of how to conduct R&D projects.

Though they reported significant increases in their understanding of the benefits of R&D, a number of firms also reported cautionary learning, such as “we learned that it is much costlier and takes longer to do R&D than we had previously imagined” and “a larger and more R&D focused team became more remote from the outcomes. They ran the risk that technical improvements were not commercially focused”.

Sixty percent of firms report an enhanced commitment to R&D resulting from the grant and 37% report that it did not change their commitment to R&D. The fact that 95% of companies have R&D as a core activity again provides context for this finding. Those companies reporting no change did so largely because they were already highly focused on R&D. Those that increased their commitment did so for a variety of reasons, including:

- The grant grew the company and fundamentally changed it to have a greater R&D focus than previously.
- Size and scale of the grant project caused capacity building and maturing of attitude to R&D.
- The demonstration and training effect of grant project.

Other reasons supporting an enhanced commitment to R&D included the development of stronger R&D networks and the view that R&D will provide the firm with a competitive edge.

Business strategies and commercialisation were less strongly affected by the grant with 51% and 50% respectively agreeing that the grant had changed these behaviours. These results are consistent with the fact that the R&D Start programme assists companies to undertake research and early-stage commercialisation of technological innovation and is not primarily focussed on changing business or commercialisation strategies. It also reflects the application process, which encourages firms to submit a commercialisation plan for the outcomes of its R&D project.

Those reporting no change did so because they had strong existing business and commercialisation strategies which adequately supported their R&D activities. Where the grants did affect business or commercialisation strategies, respondents advised that the outcomes of the R&D were often the first product or was radically different to existing products and therefore needed a new business strategy. According to one firm, the R&D resulted in an “expansion into a totally new area with a new sales force”. Other firms advised that the grant project caused a change of business model, for example, from hourly contracting rate to project rate, and that the grant planning process convinced them to commercialise their own IP rather than selling it.

A strong theme to emerge was an increased focus on the customer’s needs and how the final product would compete in the market. For example, one firm noted that it “would now consider final customer at the product development stage”. This contrasts with the approach taken in many firms where technical aspects determine the R&D project and then the company tries to market the final product. One respondent stated that the “firm now won’t commence a project without a clear view of the commercial product and its place in the market”.

Ongoing R&D in the firm

Question 30 asked whether R&D has been a core activity in the business over the last few years. Ninety-five percent of respondents indicated that R&D is a core activity for them. Indeed, many of the firms grew out of single R&D projects and ongoing R&D continues to underpin their growth. Many operate in rapidly changing markets and rely on R&D to maintain market share.

One company stated that R&D has always been a core activity, but that the grant had driven a fundamental shift in the business towards the commercialisation of this R&D and generating a return on the investment. Many firms reaffirmed the focus on commercialisation, stating that R&D was core to their business to create new products and drive business growth, rather than to create new knowledge for its own sake.

Next steps

The same set of questions have been asked of 100 firms participating in the R&D Tax Concession, as part of broader firm-based work on the outcomes from this programme. An analysis of the qualitative and quantitative data coming out of each of these studies will be undertaken. Drawing on the two sets of data, it is intended to undertake a comparison of the changes engendered in the firm by a grants-based programme and an entitlements-based programme.

Annex 2.1

SURVEY OF SELECTED PARTICIPANTS IN THE R&D START PROGRAMME

Question: If the project **had not** received a R&D Start grant, would it have proceeded in any form?

- ☐ Yes (proceed to Question 28)
☐ No. Why _____

Question: If the project **had not** received a R&D Start grant, then the project would have proceeded:

Interviewer instruction: tick the box in each row that most closely represents the respondent's view.

	Disagree strongly --	Disagree -	No change =	Agree +	Agree strongly ++
With a smaller budget					
More slowly					
With less external collaboration					
With less ambitious outcomes					
With a smaller range of potential applications					

Question: Undertaking and/or commercialising the outcomes of the R&D Start-funded project has resulted in:

	Disagree strongly --	Disagree -	Neutral =	Agree +	Agree strongly ++
A stronger understanding of the benefits to the firm from R&D and commercialisation					
An enhanced commitment to R&D in the firm, including through increased R&D resources or commencement of new projects					
One or more entrenched changes in the way the firm manages R&D projects (e.g. <i>project management, contract out, stronger milestones in place</i>)					
One or more entrenched changes in the firm's business strategy					
One or more entrenched changes in how the firm commercialises products					
New collaboration with companies that is expected to continue					
New collaboration with universities or public laboratories that is expected to continue					
Encouraged you to apply for other government grants, such as ARC Linkage grants, tax concession					

Q30: Has R&D been a core activity in your business over the last few years, or has the R&D Start grant been a one-off? If the latter, has the grant brought about some recognition about the long term benefits of R&D and a change in attitude to investment in R&D?

Annex 2.2

DEMOGRAPHIC PROFILE OF SURVEY POPULATION COMPARED WITH TOTAL GRANT RECIPIENT POPULATION

Table A2.2.1. Comparison of the survey population to the total grant population with respect to size of company (by turnover level)

Turnover level (current dollars)	3-year average* %	Current no.	Current %	Difference (percentage points)
<=AUD 500k	23.9%	23	23.0%	0.9
>500k<=\$1m	10.1%	10	10.0%	0.1
>\$1m<=\$5m	35.2%	36	36.0%	-0.8
>\$5m<=\$10m	14.3%	17	17.0%	-2.7
>\$10m<=\$25m	9.7%	9	9.0%	0.7
>\$25m<=\$50m	2.3%	3	3.0%	-0.7
>\$50m	4.5%	2	2.0%	2.5
Total	100%	100	100%	0

Table A2.2.2. Comparison of the survey population to the total grant population with respect to industry sector of company (by turnover level)

Industry sector	3-year average* %	Current no.	Current %	Difference (percentage points)
Agriculture	7.5%	10	10.0%	-2.5
Mining	4.3%	2	2.0%	2.3
Food, Textile, Wood and Printing Manufacturing	5.0%	4	4.0%	1.0
Petroleum & Chemical Mfg	5.8%	7	7.0%	-1.2
Metal & Non Metal Product Mfg	6.9%	4	4.0%	2.9
Machinery & Equipment Mfg	23.8%	27	27.0%	-3.2
Other Manufacturing	10.1%	7	7.0%	3.1
Utilities & Construction	2.1%	3	3.0%	-0.9
Trade, Accommodation & Transport	2.0%	1	1.0%	1.0
Communications, Finance & Insurance	6.2%	6	6.0%	0.2
Property, Business & Computing Services	13.1%	19	19.0%	-5.9
Govt Admin, Defence, Education, Health & Comm Services	10.6%	10	10.0%	0.6
Cultural, Sporting, Recreational, Personal & Other Services	2.6%	0	0.0%	2.7
Total	100.0%	100	100.0%	0.0

Table A2.2.3. Comparison of the survey population to the total grant population with respect to location of company (by state or territory)

State or territory	3-year average* %	Current No.	Current %	Difference (percentage points)
ACT	2.2%	2	2.0%	0.1
NSW	27.9%	35	35.0%	-7.1
QLD	16.9%	15	15.0%	1.9
SA	12.5%	13	13.0%	-0.6
TAS	5.9%	6	6.0%	-0.1
VIC	25.2%	24	24.0%	1.1
WA	9.4%	5	5.0%	4.3
Total	100%	100	100%	-0.05

Note: The data for the three-year average is taken from information in Appendices of the Annual Reports of the Industry Research and Development Board (IR&D Board) for the financial years 1999-00, 2000-01 and 2001-02. In the case of state data the grants executed data were used (rather than applications data).

Annex 2.3

COLLATED DATA

Table A2.3.1. Impact on project if grant had not been received

Response	Score	Frequency of reported response				
		Smaller budget	Slower	Less collaboration	Less outcomes	Less applications
Disagree strongly	1	0	0	0	0	0
Disagree	2	1	0	3	1	3
No change	3	5		21	12	18
Agree	4	34	21	19	24	20
Agree strongly	5	21	40	16	23	18
Number of responses		61	61	59	60	59
Average score		4.2	4.7	3.8	4.2	3.9

Table A2.3.2. **Impact of the grant on listed behaviours**

Response	Score	Frequency of reported response							
		Stronger understanding of the benefits of R&D	Enhanced commitment to R&D	Entrenched changes in R&D Management	Entrenched changes in business strategy	Entrenched changes in product commercialisation	New collaboration with companies	New collaboration with universities or public laboratories	Encouraged to apply for other grants
Disagree strongly	1							1	1
Disagree	2	1	3	1	3	2	3	6	5
No change	3	43	37	28	45	47	29	44	7
Agree	4	25	32	38	30	32	25	29	33
Agree strongly	5	30	27	31	19	17	39	18	52
Number of responses		99	99	98	97	98	96	97	97
Average		3.8	3.8	4.0	3.7	3.6	4.0	3.6	4.3

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Chapter 3

BEHAVIOURAL ADDITIONALITY OF AUSTRIA'S INDUSTRIAL RESEARCH PROMOTION FUND (FFF)

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Abstract. This chapter presents an empirical analysis of the behavioural additionality effects of subsidies from the Austrian federal R&D support scheme (FFF). Based on firm-level data, the study supports the notion that FFF-assisted companies have been successful in enhancing their innovation capabilities and building their competence in general, and in making use of new technologies and other R&D procedures.

Introduction

There is increasing awareness that R&D promotion schemes must be judged on the basis of more than their immediate material returns or directly measurable indicators. While high levels of output are often considered a necessary first-order condition for the provision of public R&D funds (Rigby, 2003) and it is generally accepted that publicly funded R&D should not substitute for (or crowd out) private R&D investment¹, intangible social returns, such as competence building and networking, also need to be taken into consideration in evaluations. These social returns may lead companies to spend more resources on innovation and R&D projects in the future.² The concept of behavioural additionality as originally introduced by Buisseret *et al.* (1995) is an attempt to steer the notion of additionality away from a narrow focus on either immediate commercial effects or various kinds of secondary effects and toward these types of social returns.

Accordingly, this chapter examines the long-term behavioural changes emerging from firms' participation in the Austrian federal industrial R&D support scheme (FFF). The chapter broadens the traditional concept of additionality by investigating whether firms' participation in projects funded by the FFF influences their R&D-related *behaviour* in a significant manner. Thus, attention is not so much drawn to the actual economic effects or the triggering of private economic funding of the projects themselves; the decisive point is rather if participation in FFF-funded projects has made the actors become more involved in R&D activities and if there have been permanent changes in the conduct of a

* Access to the FFF's project and firm database is gratefully acknowledged by the author. The author also thanks participants in the OECD Workshop on "Measuring the Behavioural Additionality Effects of Government Financing of Business R&D" (Manchester, May 2004) for helpful comments and discussions.

1. For a survey of the econometric evidence on this issue, see David *et al.* (2000).
2. Georgiou (1997, 2000, 2002), Luukkonen (2000), Papaconstantinou *et al.* (1997), Sakakibara (1997).

company, particularly in the institutionalisation of innovation and R&D-related activities (Aslesen *et al.*, 2001). In short, the focus is on the building of innovation capabilities and competence building in general as well as the companies' ability to make use of new technologies and R&D procedures elsewhere. If such is the case, this may strengthen the company's ability to absorb new knowledge. It should be noted that this form of competence building may also benefit other participants in the innovation system, including customers and collaboration partners, thus contributing to a permanent and sustainable increase in the level of Austrian R&D investment.

This study explores various dimensions of behavioural additionality resulting from FFF assistance, including project additionality, acceleration additionality, and scope and scale additionalities.³ It weaves together evidence from a recent survey of applicants for FFF funding, including those that were successful in winning funding and those that were not. It compares the results from these two populations of firms to examine how FFF funding affected decisions to proceed with proposed R&D projects and implementation of those projects; collaboration and networking in FFF-supported projects; and the degree to which proposals are based on earlier projects and/or results of subsequent projects. Finally, the study uses data from the FFF's linked firm/project database to estimate the effect of FFF subsidies on the stock of scientific R&D personnel, which is seen as an important element of firms' ability to change its R&D behaviour.

Descriptive evidence from survey data

In 2003 the FFF's customers were surveyed on their appraisal of the working of the Austrian Industrial Research Promotion Fund (FFF). Details of the survey and an overview of the sample are presented in the relevant publications of the Austrian Institute of Economic Research (WiFo) and Joanneum Research (JR). One of the interesting features of the survey is that it includes responses to questions posed to two different groups of firms: 1) successful applications that received funding from the FFF and who were asked hypothetical questions about what would have happened if they had not received FFF funding; and 2) failed applications who did not receive FFF funding and were asked questions about what actually happened to their proposed projects. Responses from these two groups can be compared to highlight differences between anticipated and realised outcomes and to detect biases in the answers of successful firms (which might answer the questionnaire strategically to highlight the importance of the FFF funds).⁴

3. For a more complete discussion of these concepts, see Davenport *et al.* (1998) and Georgiou (2002).

4. Since respondents have an interest in the continuation of public support, there is an incentive to over-emphasise the effects of public assistance measures. On the other hand one could argue that companies are reluctant to admit their dependency on public funds. In either case there is wide scope for speculation, *i.e.* we simply cannot tell the direction of distortion (Sakakibara, 1997).

Project additionality

One of the most compelling issues in the context of publicly funded projects is whether an R&D project would or would not be implemented in the absence of public funding. This dimension of additionality is occasionally referred to as “project additionality” (see Davenport *et al.*, 1998).

Tables 3.1 and 3.2 present detailed evidence on this issue derived from the FFF survey data. The data have been analysed by industry sector (Table 3.1) and firm size (Table 3.2), and allow comparisons of responses regarding hypothetical outcomes (those anticipated by successful applicants for FFF funding) with actual outcomes experienced by failed applications to the programme.

The data indicate that failure to win FFF funding has a significant effect on the conduct of R&D projects – although the actual effects differ from those that might be anticipated. The readiness of firms to carry out revised versions of rejected projects was overestimated by about 10 percentage points: 57% of firms that won FFF funding expected that they would have carried out a modified version of their project without FFF funding, but only 47% of failed applicants did so. In fact, nearly one in three failed applicants cancelled their projects, an outcome that was anticipated by only 28% of the successful applicants. Some 22% of the failed applicants reported that their projects were implemented anyway, without public assistance, an outcome that was anticipated by only 15% of supported firms. Hence, the case of full additionality (*i.e.* cancellation of the project if FFF funding was not obtained) appears systematically underestimated, as is the ultimate willingness or ability to realise the project without government support. Firms’ erroneous assessment of their actual readiness to carry out a revised version of the project was particularly evident in traditional industries and for companies with between 10 and 99 employees.⁵ Firms with fewer than 10 employees were generally more accurate in their expectations.

Public R&D assistance proves to be most crucial for companies in the service sector. Quite surprisingly, firms in manufacturing industries were more likely than service firms to carry out R&D projects without modification (*i.e.* same level of effort and schedule) when FFF funding was denied. Conversely, the share of respondents who claimed that the project would have been/has been dropped entirely without FFF funding was lowest within this subgroup (see Table 3.1). Presumably, these findings reflect some bias in the sample of surveyed firms, as the questionnaire was only sent to firms that had applied for FFF support (rather than a random sample of all firms in Austria). It is very likely that R&D-intensive manufacturing firms and service sector firms apply for FFF support on a regular basis, while traditional manufacturing firms apply only if their project is deemed to have a high chance of success and post minimal risk. This would explain why traditional industries are the least dependent on FFF funding: their projects are less risky and will be pursued anyway. More sophisticated analytical methods are therefore needed in order to produce unambiguous evidence of the additionality aspect of public R&D support.⁶

5. Here, discrepancies between hypothetical and actual outcomes range between 14% and 16% (see Tables 3.1 and 3.2).

6. For a survey of the econometric evidence over the past 35 years see David *et al.* (2000).

Likewise, an unexpected result is that it is *not* the largest firms which prove to be the least reliant on FFF funding (see Table 3.2). It is true in the hypothetical scenario that larger firms are more likely to claim that they would carry out their R&D projects regardless of the success of their application for FFF funding (25% of firms with 250 or more employees would continue without changes; 63% with modifications) and, conversely, the least likely to report that projects would be cancelled if they did not receive FFF funding (12% of firms with 250 or more employees). However, the actual consequences tell a different story. Additionality is lowest in case of companies with between 100 and 250 employees. More than 40% of such firms carried on their projects without modification after failing to win FFF funding, and only 13% cancelled their project outright. Irrespective of this irregularity, it remains true that the smallest firms (those with fewer than 10 employees) are the most vulnerable to negative funding decisions, as almost 40% cancelled their projects after failing to win FFF funding, and only 14% continued without modifying their projects. In other words, the role of FFF assistance is quite decisive in encouraging additional R&D activities within very small firms.

Table 3.1. **Implementation/non-implementation if application was/is rejected**
analysis by sector affiliation

	Hypothetical	Actual
	Scenario ¹	Consequences ²
Carry out project without changes (total)	15.13	21.85
Traditional industries	19.77	34.02
R&D-intensive industries	16.32	23.61
Traditional services	16.36	18.75
Knowledge-intensive services	8.93	12.12
Carry out a revised version of the project (total)	57.16	46.79
Traditional industries	60.47	46.39
R&D-intensive industries	59.64	47.92
Traditional services	49.09	41.67
Knowledge-intensive services	54.29	47.73
Cancel project (total)	27.72	31.35
Traditional industries	19.77	19.59
R&D-intensive industries	24.04	28.47
Traditional services	34.55	39.58
Knowledge-intensive services	36.79	40.15
Number of sample firms	985	421

1. Sample comprises companies that never have been rejected by FFF and answered the relevant question.

2. Sample comprises companies that have experienced rejection by FFF and answered the relevant question.

Behavioural changes in case of rejection

Beyond influencing decisions of whether or not to proceed with R&D projects, failure to win FFF funding has various anticipated and real effects on firm behaviour. Among successful applicants, 61% stated that they would have sought alternative sources of public assistance for their projects had they not received FFF funding. Less than one-third said they would not seek alternative funding.⁷ Larger firms were more likely to report that they would indeed seek funding from other R&D-promotion schemes if their FFF applications were turned down. Overall, only one in four failed applicants did seek alternative funds, suggesting that dependency on public R&D-assistance is broadly overestimated.⁸ Evidence on that issue is not conclusive as responses are available for only about 300 failed applicants, compared to 1 131 successful applicants that responded to the hypothetical question.⁹

Table 3.2. **Implementation/non-implementation if application was/is rejected: analysis by firm size**

	Hypothetical	Actual
	Scenario ¹	Consequences ²
Carry out project without changes (total)	15.10	21.93
Fewer than 10 employees	8.15	14.08
10 to 99 employees	14.07	19.15
100 to 249 employees	21.64	42.31
250 and more employees	25.44	26.97
Carry out a revised version of the project (total)	56.47	46.70
Fewer than 10 employees	49.22	47.18
10 and more employees	59.55	43.97
100 and more employees	56.72	44.23
250 and more employees	62.72	51.69
Cancel project (total)	28.43	31.37
Fewer than 10 employees	42.63	38.73
10 and more employees	26.38	36.88
100 and more employees	21.64	13.46
250 and more employees	11.83	21.35
Number of sample firms	1020	424

1. Sample comprises companies that never have been rejected by FFF and answered the relevant question.

2. Sample comprises companies that have experienced rejection by FFF and answered the relevant question.

7. Share of missing answers: 8%.

8. Share of missing answers: below 1%.

9. In the actual scenario, companies that abandoned their proposal after failing to win FFF funding are deleted from the relevant sample.

Failure to receive funding had a significant effect of the scheduling and duration of projects. Among firms indicating that proposed projects would have been implemented in a revised form if FFF funding were not received,¹⁰ two-thirds indicated that project results would be exploited later than originally anticipated (Table 3.3), highlighting the importance of so-called acceleration additionality.^{11,12} This result was consistent across the hypothetical and actual scenarios. Acceleration additionalities originate as an immediate consequence of postponed starting dates and prolonged implementation phases in those cases in which public sponsorship was not received. In fact, delays generally turn out much more severe than expected. More than 60% of the failed applicants admit prolonged project duration, an effect anticipated by only one-half of successful applicants.

Table 3.3. **Behavioural additionality: adaptations if application was/is rejected**

At issue		Hypothetical	Actual
		Scenario ¹	Consequences ²
Starting date of the project	Postponed	32.03	43.35
	Remains unchanged	61.02	48.77
Duration of the project	Longer	50.68	61.08
	Remains unchanged	30.34	23.15
Accessibility of project results	Later	62.71	63.55
	At no later point in time	31.02	27.59
Scale of the project	Smaller	74.07	60.10
	Remains unchanged	21.53	32.51
Technical demand	Less sophisticated	48.81	39.90
	Remains unchanged	46.78	51.72

1. Refers to question 42; N=590; very few firms report an *earlier* starting date, *shorter* duration of the project, *greater* scale of the project or *higher* technical demand. The share of missing answers ranges between 3%-4%.

2. Refers to question 57; N=203; very few firms report an *earlier* starting date, *shorter* duration of the project, *greater* scale of the project or *higher* technical demand. The share of missing answers ranges between 4%-7%.

Most interestingly, firms with between 100 and 250 employees deviate from the norm. Among failed applicants in this size category, less than one in three reported that failure to win an FFF award resulted in delays in project implementation, and one in five firms indicated that even without government funding the project was finished earlier than originally planned. Furthermore, among successful applicants of this size, more than three in four claimed they would have stuck to the original time schedule if they did not receive funding, and only one in five companies expected that the starting point would have been postponed. Similar results were obtained for traditional service-sector companies. In summary, there seems to be some evidence that large (but not the largest) firms, as well as traditional service-sector firms, do not really change their behaviour when they fail to receive FFF funding, but rather make concessions to the time horizon of the project. This notion is supported by results from a previous customer content analysis

10. For the hypothetical question N=590, while 203 respondents report what actually happened when a revised version of the rejected proposal had been carried out.
11. Acceleration additionality refers to the case in which R&D assistance speeds up the conduct of the project (Georghiou, 2002).
12. Within traditional service sector companies the respective fraction amounts to only 42% when asked hypothetically. Actual consequences do not differ in a statistically significant way.

based on the same survey data. Here, firms of between 100 and 250 employees were found to invest the least time in seeking FFF support. They might thus simply be unable to respond to failed applications in anything but a rather pragmatic way.

Failure to receive FFF funding has effects on technical challenge and project scale as well, but less than firms might anticipate. While about half the firms expected that failure to win funding from the FFF would force them to reduce the technical challenge of their R&D projects, only about 40% of failed applicants reported such a reduction. The same is true for the scale issue. Three-quarters of successful firms anticipated that failure to win funding would result in a reduction in the scale of their effort. Some 60% of rejected firms reported that they carried out the proposed project on a smaller scale when FFF assistance had been denied. Hence, so-called scale additionalities are prevalent to a considerable degree, even if not to the degree anticipated.

Collaboration and networking

Collaboration and networking must be considered key aspects of participation in government-sponsored projects. They involve both individual and organisational learning, generate network externalities and thereby influence the competences of the actors, as well as their future behaviour (Aslesen *et al.*, 2001, Georghiou, 1997). Furthermore, working closely with R&D institutions enhances companies' absorptive capacity as regards scientific knowledge. In the FFF survey, at least every other respondent claimed that collaboration took place in one way or another in the context of FFF-funded projects (see Table 3.4). Collaboration may take the form of joint project proposals (true for 52% of the FFF-funded firms), co-operation with research institutes (true for 51% of FFF-funded firms) or co-operation with other companies (true for 55% of FFF-funded firms). It is not clear, however, whether *additional* partnerships were established or if existing partnerships were continued in the FFF-funded project. A previous empirical study undertaken in New Zealand, for example, showed that only about 10% of the government-assisted projects resulted in new partnership (Davenport *et al.*, 1998).

Table 3.4. **Behavioural additionality: collaboration and networking (question 38)**

	Yes	No	Missing
Joint project proposal with customers/suppliers/research partners	52.43	37.75	9.81
Co-operation with research institutes	50.84	38.11	10.96
Co-operation with other companies	55.35	33.69	10.88
Building of research networks	31.39	56.23	12.38

Collaboration appears to be most intensive among more traditional companies. Firms in more traditional parts of the manufacturing and service sectors aim to compensate for their own limitations by making use of the knowledge in research institutions via collaboration. Most surprisingly, highly specialised small firms are particularly prone to build their own research networks, and collaboration is rather complementary than substitutive in nature. Generally speaking, service firms are more involved in research networks and are more responsive to team work with other companies. In other words, supporting

service firms are more likely to generate so-called scope additionalities¹³ as the benefits of public R&D assistance spill over to collaborating partners, while the diffusion effects are moderate in case of the manufacturing firms.

Preceding and subsequent projects

If FFF participation enhances a company's own R&D efforts, such increased commitment should ultimately result in subsequent projects. In total 485 firms, accounting for 43% of the relevant sample, report that participation in the FFF funding scheme resulted in successive projects that are directly based on preceding, FFF-sponsored research projects (see Table 3.5).¹⁴ Likewise, roughly the same fraction states that the FFF-sponsored project just happens to be the later project, *i.e.* the proposal was based on a project that had been carried out before. Chain effects (in both directions) are the most likely to occur within R&D-intensive manufacturing or knowledge-intensive services, where at least every other firm bases FFF proposals on previous projects, or vice versa. Furthermore, three out of four firms within the R&D-intensive manufacturing or knowledge-intensive services appreciate the value of FFF support insofar as R&D activities could be extended to new areas. Such extensions imply changes at the strategic level (*i.e.* to move into a new area of activity) as well as changes at the level of competences to be acquired in the future. More traditional firms, on the other hand, show a significantly lower readiness to enter unknown research territory so that in total only about two in three companies extend their research scope. Still, the triggering effect of FFF participation must be regarded as a definite success.

Table 3.5. **Behavioural additionality: chain effects of public funding**

	Yes	No	Missing
FFF project is based on former R&D projects of our company	44.39	44.47	11.14
FFF project has resulted in subsequent projects	42.88	49.96	7.16
Project allowed us to extend R&D activities to new areas	62.86	26.44	10.70

Econometric evidence from the FFF panel data set

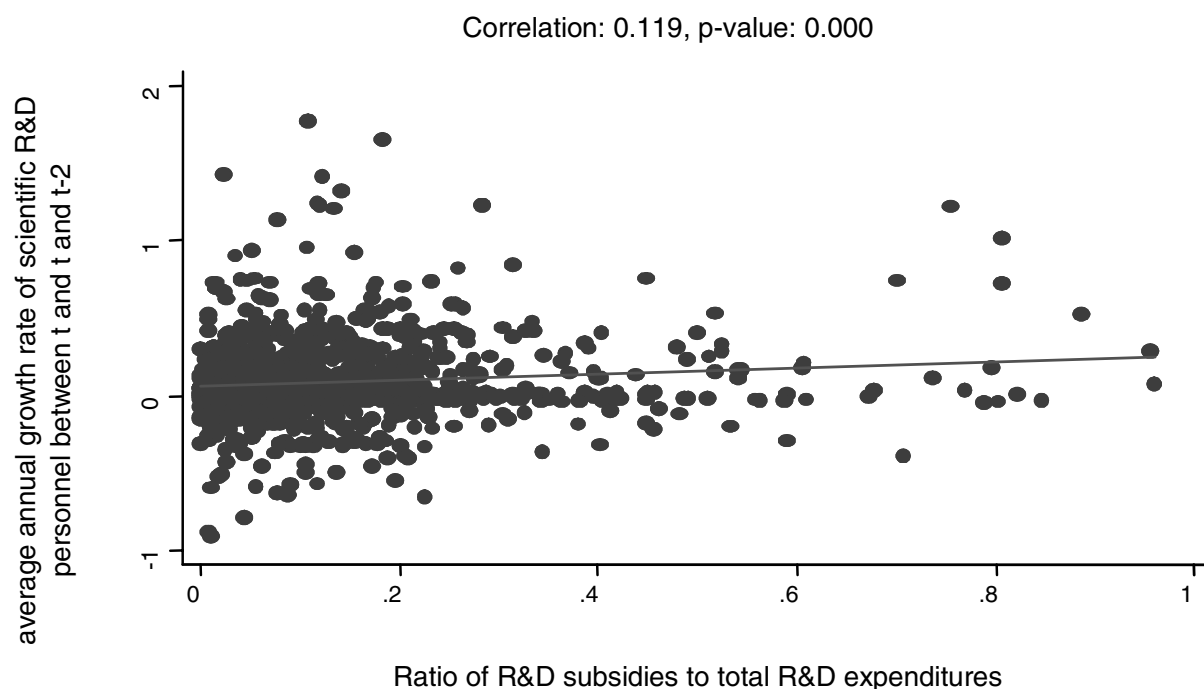
The standard econometric approach to evaluating input additionality is to regress measures of private R&D resources (*e.g.* R&D expenditure or scientific labour input) on indicators of public assistance (*e.g.* level of public funding), correcting for selectivity. Using such techniques to measure behavioural additionality is a challenging task. Behavioural additionality deals with differences in firm behaviour resulting from government intervention (Georgiou, 2003) and evaluations of behavioural additionality must aim to capture *intangible* benefits, such as training of researchers, increased awareness of R&D opportunities and establishment of informational networks (Sakakibara, 1997).

13. Scope additionalities refer to an outcome such that “the coverage of an activity is expanded to a wider range of applications or markets than would have been possible without government assistance (including the case of creating a collaboration in place of a single company effort)” (Georgiou, 2002).
14. Some 38% of the firms (*i.e.* 182 firms) were successful in obtaining public support for follow-up projects as well (no significant difference across sector affiliation or firm size). Out of these, 79% managed to again attract FFF subsidies, 44% received financial assistance from other Austrian R&D promotion schemes and 12% were funded by the European Union. Note that some companies received assistance from more than one source.

In an effort to identify an indicator that would capture these behavioural effects, it was agreed to run regressions against the number of R&D personnel, which is a variable contained in the FFF's firm project database.¹⁵ This specification sheds some more light on the issue of input additionality in an orthodox sense, but additional R&D personnel will certainly facilitate increased awareness of R&D opportunities, the establishment of informational networks, and the like, and will hence improve the firm's absorptive capacity with respect to new knowledge. Ultimately, the differences between input additionality and behavioural additionality, measured in this way, are hard to tell apart and even harder to quantify.

Figure 3.1 presents preliminary results of a bi-variate analysis of the relationship between the initial R&D subsidy ratio (*i.e.* FFF-subsidies as a share of total R&D-expenditure) and the average annual growth rate of R&D-personnel. Although the correlation turns out statistically significant and positive, the coefficient of correlation is very small in magnitude.

Figure 3.1. Correlation between the initial R&D subsidy ratio in and the growth rate of R&D personnel in the following two years



Note: Number of observations (firms) is 1405.

15. For a description of the dataset, see Falk (2004).

Table 3.6. **Panel estimates of the determinants of log (scientific R&D personnel)**

	coeff.	t-value	p-value
Year dummy 1996 (ref. 1995)	0.02	0.66	0.51
Year dummy 1997	0.06	2.08	0.04
Year dummy 1998	0.08	2.91	0.00
Year dummy 1999	0.13	4.23	0.00
Year dummy 2000	0.17	5.46	0.00
Year dummy 2001	0.23	7.21	0.00
Year dummy 2002	0.28	7.37	0.00
Founded in the last five years	0.00	-0.07	0.95
log R&D subsidies (net present value)	0.04	4.31	0.00
log total sales	0.19	10.89	0.00
Food & bev., textiles and clothing	-0.17	-1.05	0.30
Wood, paper, publishing	-0.60	-3.23	0.00
Chemicals, rubber	0.26	1.85	0.06
Non-metallic mineral products	0.06	0.29	0.77
Metals, fabricated metal products	-0.41	-2.68	0.01
Electrical machinery, instruments	0.83	6.88	0.00
Transport equipment	0.61	3.36	0.00
Other manufacturing	0.08	0.22	0.83
Computer services	1.06	7.26	0.00
Other industries	-0.15	-0.66	0.51
Limited liability company (GMBH)	0.36	0.90	0.37
10-24 employees	0.46	3.89	0.00
25-49 employees	0.73	5.19	0.00
50-99 employees	0.67	4.54	0.00
100-249 employees	0.81	5.62	0.00
250-499 employees	1.29	8.02	0.00
> 500 employees	2.38	13.39	0.00
log project duration in months	1.23	1.53	0.13
Constant	-5.13	-2.44	0.02
Number of observations (firms)	3031 (1064)		

Note: Dependent variable is log scientific R&D personnel. Estimates are based on the Hausman-Taylor estimator (fixed effects with time-invariant variables). The references for industry and size dummies are machinery and 0-9 employees, respectively.

The multivariate analysis fit a fixed effects model with time-invariant variables as introduced by Hausman and Taylor (1981). Results are displayed in Table 3.6. Coefficients on the year dummies indicate that the number of scientific R&D staff increased by 32% between 1995 (the reference year) and 2002.¹⁶ Results on the other control variables are likewise plausible. Companies undertaking R&D in computer-related services or in high-tech electrical machinery employ significantly more R&D workers than the reference group. Apparently the number of scientific R&D personnel increases with firm size (this is something of a tautological relationship). With respect to the actual variable of interest, R&D subsidies, a highly significant coefficient of very small magnitude confirms the results of the bivariate analysis displayed in Figure 3.1. A 1% increase in the amount of R&D subsidies granted will induce firms to increase its scientific R&D staff by 0.04%. To illustrate, suppose the company employs 40 R&D workers.¹⁷ Hiring one additional worker would increase the stock of R&D personnel by 2.5%. In order to achieve this 2.5% increase (or to hire exactly one more R&D worker), the net present value of FFF subsidies would have to increase by 62.5%.

These results imply that demand for highly skilled R&D personnel is only marginally affected by additional FFF assistance. Instead, demand is driven by fundamental performance indicators such as total annual sales, or by the industry classification of the firm with the supported project.

In qualitative terms, the above findings are confirmed if the same regression is run on samples of various sized firms (Table 3.7). Comparing the crucial coefficients across size categories, it is found that the demand for scientific R&D labour is more elastic with respect to FFF funding among the smaller firms. In particular, a statistically insignificant coefficient on $\log(\text{subsidies})$ points to the fact that the largest firms hire additional R&D workers irrespective of additional FFF funding.

16. See Halvorsen *et al.* (1980) on the correct interpretation of dummy variables in semi-logarithmic equations.

17. This is the average number of scientific R&D personnel in the linked firm-project database.

Table 3.7. Panel estimates of the determinants of the logarithm of scientific R&D personnel: detailed results by firm size

	100 and more employees			25-99 employees			Fewer than 25 employees		
	coeff.	t-value	p-value	coeff.	t-value	p-value	coeff.	t-value	p-value
Year dummy 1996 (ref. 2002)	0.03	0.71	0.48	-0.03	-0.39	0.70	0.05	0.76	0.45
Year dummy 1997	0.06	1.71	0.09	0.04	0.53	0.59	0.08	1.16	0.25
Year dummy 1998	0.08	2.05	0.04	0.09	1.21	0.23	0.07	1.05	0.29
Year dummy 1999	0.10	2.78	0.01	0.05	0.62	0.54	0.21	2.88	0.00
Year dummy 2000	0.16	3.98	0.00	0.07	0.77	0.44	0.22	3.01	0.00
Year dummy 2001	0.23	5.56	0.00	0.14	1.55	0.12	0.27	3.47	0.00
Year dummy 2002	0.26	5.56	0.00	0.16	1.58	0.11	0.34	3.83	0.00
Founded in the last five years	-0.08	-1.45	0.15	0.01	0.09	0.93	0.08	1.45	0.15
log subsidies (net present value)	0.02	1.52	0.13	0.05	2.22	0.03	0.07	3.83	0.00
log total sales	0.24	7.70	0.00	0.26	6.04	0.00	0.14	5.05	0.00
Food & bev., textiles and clothing	-0.51	-1.95	0.05	0.25	0.80	0.43	0.19	0.75	0.45
Wood, paper, publishing	-1.12	-3.80	0.00	-0.10	-0.25	0.81	-0.12	-0.48	0.63
Chemicals, rubber	0.09	0.35	0.73	0.57	1.87	0.06	0.07	0.42	0.68
Non-metallic mineral products	-0.05	-0.13	0.90	-0.14	-0.32	0.75	0.29	0.78	0.43
Metals, fabricated metal products	-0.65	-2.68	0.01	-0.12	-0.40	0.69	-0.28	-1.17	0.24
Electrical machinery, instruments	0.95	3.94	0.00	1.12	4.83	0.00	0.46	3.26	0.00
Transport equipment	0.69	2.44	0.02	0.24	0.60	0.55	0.12	0.44	0.66
Other manufacturing	-0.25	-0.50	0.62	0.38	0.34	0.73	0.42	0.95	0.34
Computer services	0.69	1.55	0.12	1.36	4.94	0.00	0.69	5.27	0.00
Other industries	-0.74	-1.58	0.11	-0.01	-0.02	0.98	0.18	0.74	0.46
Limited liability company (GMBH)	6.35	3.37	0.00	-0.53	-0.98	0.33	0.00	0.01	1.00
10-24 employees							0.43	4.92	0.00
25-49 employees									
50-99 employees				-0.07	-0.44	0.66			
100-249 employees									
250-499 employees	0.45	2.60	0.01						
> 500 employees	1.46	7.69	0.00						
log project duration in months	0.79	0.41	0.68	1.08	1.13	0.26	-0.07	-0.12	0.91
Constant	-9.32	-1.67	0.09	-4.06	-1.60	0.11	-1.20	-0.83	0.41
Number of observations (firms)	1501 (390)			638 (237)			892 (437)		

Note: Dependent variable is log scientific R&D personnel. Estimates are based on the Hausman-Taylor estimator (fixed effects with time-invariant variables). The references for industry and size dummies are machinery and 0-9 employees (specification 1), 50-99 (specification 2) and >500 (specification 3), respectively.

Some evidence on a dynamic specification resulting from a partial adjustment model is presented in Table 3.8.¹⁸ Coefficients on year dummies turn out to be insignificant and the trend effect (persistence) is captured by the lagged endogenous variable instead. It is found that contemporaneous, as well as lagged subsidies have a positive short-run effect on the number of scientific R&D workers of 0.02%. The long-run effect of 0.06% is calculated as the sum of contemporaneous and lagged effects (one period) divided by the partial adjustment coefficient.¹⁹ These effects match the results of the static approach (Table 3.6) remarkably well and once again support the finding that increased FFF sponsoring impacts only marginally on the additional demand for highly skilled R&D labour.

Table 3.8. **Impact of subsidies on scientific R&D personnel: dynamic panel estimates**

	(1)			(2)		
	coeff	t-value	p-value	coeff	t-value	p-value
$\Delta \log$ R&D personnel (t-1)	0.22	1.76	0.08	0.24	1.98	0.05
$\Delta \log$ R&D subsidies (t)	0.02	1.65	0.10	0.02	1.68	0.09
$\Delta \log$ R&D subsidies (t-1)	0.02	2.12	0.04	0.02	2.12	0.03
$\Delta \log$ sales (t)	0.06	2.42	0.02	0.06	2.18	0.03
$\Delta \log$ sales (t-1)	0.05	2.03	0.04			
Newly founded	0.00	0.04	0.97	0.01	0.44	0.66
Year dummy 1997 (ref 2001)	-0.01	-0.44	0.66	-0.02	-0.64	0.52
Year dummy 1998	-0.02	-1.10	0.27	-0.02	-1.16	0.25
Year dummy 1999	0.02	0.85	0.40	0.02	0.71	0.48
Year dummy 2000	0.02	1.01	0.31	0.02	0.92	0.36
Constant	0.02	1.16	0.25	0.02	1.51	0.13
nobs (firms)	1186 (422)			1186 (422)		
Implied long run subsidy effect	0.06			0.06		

Note: One-step estimates based on heteroscedasticity robust standard errors. Data consist of all firm-year observations with non-missing and non-zero values of subsidies and sales.

Given the overall disappointing and fairly robust results of the econometric exercise, is FFF funding at least a useful instrument to boost R&D employment within small firms? The answer is yes, in relative terms, and clearly no in absolute terms. To illustrate, take the extreme case of a one-person firm. One additional R&D employee translates into a doubling of the existing stock of scientific labour (+100%). A 1% increase in FFF subsidies would induce the labour stock to rise by 0.07%. To let it rise by 100%, FFF subsidies would have to grow by more than 1400%.²⁰ Table 3.9 illustrates this argument.

18. This specification has been suggested by Lach (2000).

19. Partial adjustment coefficient = $(1 - \text{coefficient on the lagged endogenous variable})$.

20. This estimate is based on the calculation $(100/0.07)=1,428.6$

Table 3.9. Increase in FFF subsidies necessary to employ one additional R&D worker

Refers to	Size classes	Coefficient on log(subsidies)	Number of scientific R&D personnel (various scenarios)	Percentage increase in FFF subsidies necessary to hire one more R&D worker
Table 6	all	0.04	40	62.5
Table 7, columns 8-10	smaller	0.07	1	1428.6
Table 7, columns 8-10	firms	0.07	12	119.0
Table 7, columns 8-10	only	0.07	24	59.5
Table 7, columns 5-7	medium-	0.05	25	80.0
Table 7, columns 5-7	sized	0.05	62	32.3
Table 7, columns 5-7	firms	0.05	99	20.2
Table 7, columns 2-4	larger	0.02	100	50.0
Table 7, columns 2-4	firms	0.02	300	16.7
Table 7, columns 2-4	only	0.02	500	10.0
Table 8, short-run effect	all	0.02	40	125.0
Table 8, long-run effect	all	0.06	40	41.7

Note: The following formula applies: $((X+1)*100)/X - 100)/c$, where X denotes the existing stock of scientific R&D personnel and c gives the estimated coefficient on log(subsidies).

How can unambiguous evidence of high behavioural additionality from the FFF survey data be reconciled with the moderate effects from the econometric approach? The first approach recalls the near impossibility of capturing what Papaconstantinou and Polt (1997) call the “soft side of innovation” (networking, learning effects, co-operation, innovative behaviour, etc.). Except for the growth of R&D personnel there is no variable in the FFF project database that can be regarded as a proxy for firms’ improved abilities to absorb new knowledge and use it accordingly. The analysis just estimates what can be measured and estimated. A second, arguably more technical, response relates to the fact that the FFF requires companies to reveal certain performance indicators and firm characteristics only when they apply for funds. At this stage information from the three preceding accounting years is mandatory; ex-post figures are available only implicitly and for supported firms that repeatedly submit new research proposals. For analytical purposes, therefore, the relevant sample set is highly selective and biased in favour of firms with more or less continuous R&D performance. Even if further behavioural changes for these firms were not subject to the law of diminishing returns, the need for an ever greater R&D staff certainly is.

Summing up

This paper examines long-term behavioural changes emerging from participation in R&D funding programmes of the Austrian FFF. Descriptive evidence from survey data revealed that FFF funding is indeed generating various dimensions of behavioural additionality:

- *Project additionality*: between 80% and 85% of the sample firms would have revised their project plans or cancelled R&D projects without FFF support.
- *Acceleration additionality*: two-thirds of the sample firms were able to complete their projects more quickly because of FFF funding.
- *Scale additionality*: 74% of companies expected they would have to reduce the scale of their project without FFF support – and 60% actually did scale back their projects without FFF support.
- *Scope additionality in terms of collaboration*: at least half of firms report collaboration with research institutes or other firms either in preparing project proposals or implementing FFF-funded projects.
- *Scope additionality in terms of research topics*: more than 62% of respondents benefit from scope additionalities insofar as they were able to enter new research areas via FFF-funded projects.

Some subsequent econometric exercises based on the linked company-project FFF database aimed to show the effect of FFF funds on levels of R&D workers in supported companies, but produced inconclusive results regarding behavioural additionality. This resulted in part from the lack of appropriate quantitative measures for capturing the mostly intangible merits of behavioural additionality, as well as from limitations in the data for measuring firm characteristics after receipt of FFF funding. One might expect that FFF funding would have its most significant effect on firms' that do not undertake R&D activities on a regular basis. Unfortunately, this is exactly this type of firm for which data is most lacking. Better data is available for routine R&D performers only. Even if behavioural changes for these firms were not subject to the law of diminishing returns, their need for more R&D workers certainly would be. To address this limitation, the FFF could consider requiring firms that receive public funding to provide more ex-post information.

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Chapter 4

BEHAVIOURAL ADDITIONALITY IN AUSTRIA'S K-PLUS COMPETENCE CENTRE PROGRAMME

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Abstract. Competence centre programmes have become highly popular in several countries over the last decade. The underlying policy approach aims at stimulating the efficiency of innovation activities by promoting (research) partnerships between the diverse players from both the knowledge-generating and the exploiting sector of the innovation system. Accordingly, the Austrian *Kplus* programme promotes the link between science and industry via long-term RTD co-operation and networking in publicly funded infrastructures (the competence centres). Due to the complexity of such promotion schemes, monitoring and assessment of additionality is a challenging task. The *Kplus* programme therefore has a well-defined evaluation system, which consists of different procedures such as ex-ante, interim and ex-post centre assessments, as well as a monitoring exercise at the firm level. The related survey is a further effort to investigate the programme's additionality, this time by collecting and analysing relevant research and innovation data of the partnering firms. Although it is difficult to separate the effects of the *Kplus* programme from other (RTD) activities of those firms, the first findings, especially with respect to behavioural additionality, are presented in this chapter.

The Austrian *Kplus* competence centre programme

The *Kplus* funding initiative was set up in 1998 by the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT). This programme does not directly fund business R&D, but aims at the promotion of science-industry linkages. The main objective of *Kplus* is to build up long-term research collaboration between the public and the private sector at an advanced level by the establishment of competence centres.¹ The programme's operative management has been entrusted to the Austrian Research Promotion Agency (FFG, formerly *Technologie Impulse Gesellschaft*, abbreviated TIG).

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1. For more details visit <http://www.kplus.at>

The *Kplus* competence centres are research establishments set up for a limited period of time. They are designed to conduct high-level, pre-competitive R&D of both scientific and economic relevance. The *Kplus* centres typically originate from a joint effort of universities or contracted research organisations and some business partners. They undergo a competitive two-step selection procedure based on established quality criteria. First, a consortium consisting of one or more universities and/or non-university research institutes as well as at least five industry partners has to be formed. Then, a preliminary proposal containing information on the basic intentions of the *Kplus* centre is submitted to the FFG. These applications are evaluated externally with respect to their financial, and organisational aspects as well as their scientific and technical quality. Applicants that are judged positively are invited to submit a full proposal, which is again externally evaluated (by national and international experts) and site visits are carried out. On the basis of the evaluation, an independent jury draws up a ranking and submits a funding recommendation for the best centres. Final approval for public funding and the establishment of a *Kplus* centre is decided by the Ministry based on the recommendation of the jury. *Kplus* centres usually have a life span of seven years. Once approved, a centre receives funding for a provisional period of four years. During the fourth year the centre is subjected to a mid-term audit. Depending on this evaluation, funding can be extended for three more years.

The pilot phase of *Kplus* started in 1998, at the end of which five *Kplus* centres were selected and granted public funding. Two subsequent calls for tender followed, resulting in the establishment of a further 13 centres. Thus, today 18 *Kplus* competence centres are active, supported by some 270 industry partners and some 150 partners from the research sector.

The highest possible share of public funding for a *Kplus* centre is 60%. The remaining 40% of the financing is contributed by the industrial partners either as capital or partial payment to personnel or material costs up to a maximum of 50%. The largest part of public funding is provided by the FFG with 35% of the total budget. Twenty percent of the public monies are split between federal provinces, communities, interest groups (e.g. chambers) and 5% are borne by the research institutes involved. It is a prerequisite for public funding that the partnering firms co-finance the centre during the whole funding period. The partners can withdraw on a specific date once a year whereas new industry partners can join the centre at any time.

Kplus centres are legal entities which usually have the status of *GmbH* (comparable to “Limited” companies). Both business and research partners are collectively responsible for the centre and influence its establishment and operations either as owner or as member of a central decision-making panel (board or steering committee). The ownership structure can be decided by the respective partners. In general, firms co-operate under the roof of a *Kplus* centre in the form of multi-company projects in which industry and science partners seek problem solving and research co-operatively.

The *Kplus* centre's scope and dimension in brief:

- Annual budget totals EUR 2-4 million.
- 5-15 leading scientific staff.
- 20-40 scientific/technical employees (full-time equivalent).
- At least 5 companies.
- Duration 7 years (4 + 3 years).

Usually *Kplus* competence centres kick off with three to seven key persons, ten to twenty scientific-technical employees, management and administration. The final size of a centre is normally reached after two to three years of operation.

The *Kplus* programme has various objectives:

- Improved exploitation of existing knowledge and production of new knowledge via long-term promotion schemes with high additionality effects in the science and industry sector.
- Increase Austria's attractiveness as an industry and research location and ensure Austria's international research competitiveness.
- Achieve national competence and critical masses in industry-oriented research.
- Increase Austria's participation in international research programmes, especially in the EU's Framework Programmes, by creating appropriate national competence.
- Boost the acceptance of long-run, strategic research among the public and among the scientific community.

The research project and the methodology applied

In 2001 the *Kplus* managing agency, the FFG, invited Joanneum Research to a workshop at which the design of the evaluation system for the *Kplus* programme was debated. In order to secure the realisation of the intended programme objectives (the main objective being the enhancement of Austria's research by promoting collaboration between the science and industry sectors) data from different sources were needed. While the performance of a single *Kplus* centre is monitored via reporting and is evaluated during the mid-term audit, there was limited information available about a centre's partnering firms. To gain more insight about the industry partners, particularly with respect to the effects resulting from the *Kplus* programme, an investigation was commissioned to Joanneum Research. Accordingly, a survey was conducted, which aimed to find evidence of additionality in the *Kplus* programme based on firm-level data. In accordance with the programme management's request, the purpose of the empirical analyses was twofold: the results obtained from the data (analysed separately for each competence centre) should be used by the FFG, the centres and their partners for decisions on further development; and the findings of the data analyses of the entire sample should assist the FFG in monitoring the impact of the *Kplus* programme.

The *Kplus* competence centre programme covers a systemic policy approach to stimulate the efficiency of innovation activities by promoting (research) partnerships between the diverse players from the knowledge-generating and exploiting sector of the innovation system. That is, *Kplus* primarily aims to improve networking and collaboration between the science and industry sectors. Therefore, additionality -- especially behavioural additionality (*i.e.* changes in firms' behaviour or rather strategies resulting from the intervention) -- is of major interest in the research project.

The additionality concept is closely related to the justification of public intervention and the evaluation of funding programmes. R&D policy instruments are evaluated by unveiling the resulting additional (positive) effects. The underlying question to be answered is what would have happened without public intervention or (more specifically) in the absence of a certain programme. In empirical research this counterfactual situation is usually modelled with data of individuals or entities which are not beneficiaries of the

programme. In the study under consideration, the composition of a reliable control group was not feasible for several reasons. In Austria, the number of firms collaborating with universities and public research institutes is limited. Most of them were expected to participate in the *Kplus* programme. Moreover, business surveys suffer from low return rates, usually ranging between 3% and 10%. The time and effort necessary for contacting a sufficient number of non-participants (in order to establish a representative group of firms not participating in the *Kplus* programme) exceeded the budgetary constraints of the research project. Due to these constraints, a before/after comparison was used instead of a control group approach. In order to detect programme-related changes, data representing two points in time were collected. Accordingly, participating firms had to provide information on the situation before the respective *Kplus* centre had started its operation and on the situation four years later.

To find evidence of additionality, a questionnaire was designed containing two blocks of questions: one pertaining to firms' R&D-related characteristics and the other to programme-specific topics. The *Kplus* centres' partnering firms were asked for general information such as turnover, number of employees, R&D employees, R&D expenses, etc., and about *Kplus* programme-related information such as motives for participation, expectations, generated outcomes, and so forth. In accordance with the discussions held with the FFG, the questionnaires were distributed by the *Kplus* centre's management during the centre's mid-term audit in the fourth year of operation. As the *Kplus* centres started operation at different points in time, the dates of the mid-term audits (and thus the point in time of the data collection for the mid-term audits) vary and the questionnaires were adapted to the different centre starting dates to cover either the period 1997-2001 or 1998-2002. The findings presented in the subsequent section are based on the available data from the industry partners of the first 12 *Kplus* competence centres. The collection of data for the remaining six centres and the respective analyses were scheduled to start in autumn 2005 in accordance with the dates of their mid-term assessments. The questionnaire was adapted accordingly.

The questionnaires were distributed to the industry partners (*Kplus* firms) of the following twelve *Kplus* centres, which received approval for public funding between 1998 and 2000:

- ACV (Advanced Computer Vision).
- BMT (Bio-Molecular Therapeutics).
- CTR (Carinthian Tech Research).
- ECHEM (Applied Electrochemistry).
- FTW (Research Centre Telecommunications, Vienna).
- KNOW (Knowledge Management Centre).
- LCM (Linz Centre of Competence in Mechatronics).
- LKR (Ranshofen Light Metal Competence Centre).
- MCL (Leoben Materials Centre).
- SCCH (Software Competence Centre Hagenberg).
- VRVis (Centre of Virtual Reality and Visualisation).
- WOOD (Wood Composites and Chemistry Competence Centre).

About 75% of the questionnaires were returned, resulting in a sample of 118 partnering firms affiliated to the 12 competence centres. On the basis of the collected quantitative and qualitative firm-level data, the performance of the business partners was examined and some of the impacts related to the *Kplus* programme were evaluated. The study aimed not only at addressing input/output-related issues, but also behavioural effects resulting from *Kplus*. A selection of survey results indicating behavioural additionality at firm level obtained so far in this ongoing exercise is presented in the section below.

In order to validate the findings, different possibilities were discussed at the workshop. The first idea was to use data from the third Community Innovation Survey (CIS), because the Austrian questionnaire asks about participation in any of the Austrian competence centre programmes. Even though the questions in the CIS are not very comparable to the survey questions, certain CIS questions were analysed. Analyses of CIS questions that focused on co-operative activities and the information sources for innovative activities confirmed that collaboration is of greater importance for *Kplus* firms than for comparable non-*Kplus* firms in the CIS firm sample. Another approach is currently being taken to underline the empirical evidence on behavioural additionality found in the study with results gained from a qualitative investigation in which focus groups are applied. The purpose of the study is to learn more about the work experiences actually made in the course of the *Kplus* programme, *i.e.* how people from both sides (industry and science) assess the work of the competence centres, how they feel about co-operation and about their partners, and whether there are differences between research in the business sector compared to the science sector or in comparison with research at the competence centres.

Main findings

Before presenting a selection of survey results, the following is a brief description of the sample. The analysis is based on data from 118 industry partners in 12 *Kplus* competence centres. On average, a *Kplus* centre comprises ten industry partners. Large firms with 250 or more employees present 56% of the sample. The remaining business partners are SMEs, of which almost half are medium-sized with between 50 and 249 employees. The size structure of the industry partners varies between the different *Kplus* centres. However, in eight of the 12 centres, the majority of industry partners are large firms. Looking at the age pattern of the responding firms reveals that one-third of them had been operating for less than ten years. Most of these *Kplus* partnering firms were established in the second half of the 1990s and are small to medium-sized.

With regard to the amount and development of the firms' innovation activities, a positive trend is observable in the period under investigation. As seen in Table 4.1, 78% of *Kplus* firms increased their innovation expenditures within the four-year period under review. Some firms also provided the growth rate of their innovation expenditures.²

2. The percentage changes of the innovation expenditures stated by the firms were weighted with the R&D expenditures given for the base year 1997/98.

Table 4.1. **Development of the innovation expenditures of *Kplus* partnering firms**

Innovation expenditures	1997/98-2001/02		Estimated change	
	Number of firms	Share [%]	Number of firms	Weighted average
Increased	92	78.0	66	+ 28,7%
Stable	16	13.6	16	-
Decreased	3	2.5	2	- 13,5%
n.a.	7	5.9	34	-
Total	118	100.0	118	

A comparison with the CIS3 data reveals that *Kplus* partnering firms are more active in terms of innovation. All of the *Kplus* business partners launched either a product or process innovation or both in the CIS observation period 1998-2000, and in consequence are judged as being innovative. Whereas less than half of the non-participants are defined as being innovative (for a macro-level comparison, an overall of 49% of Austrian businesses are innovative according to the CIS and Statistics Austria's definition).³ Furthermore, the *Kplus* partnering firms have a stronger international focus than the non-participants. 78% of the *Kplus* firms responded that their retail activities are on international markets, whereas the majority of non-participating firms focus mainly on the Austrian market.

Another aspect worth investigating is the nature of the private R&D activities. The following development was observed with respect to internal and external R&D: in the year 1997/98 firms invested an average of 90% of total R&D expenditures in in-house R&D, while 10% were commissioned to external contracting parties. Four years later, the share of investments in contractual R&D had doubled and amounted to 22% of total R&D expenditures on average. This increase of firms' investments into external R&D benefits the *Kplus* centres as well. In the year 2001/02 the *Kplus* centres received an average of 5.7% of total R&D expenditures spent by the partnering firms (see Table 4.2).

Table 4.2. **Distribution of *Kplus* firms' R&D expenditures**

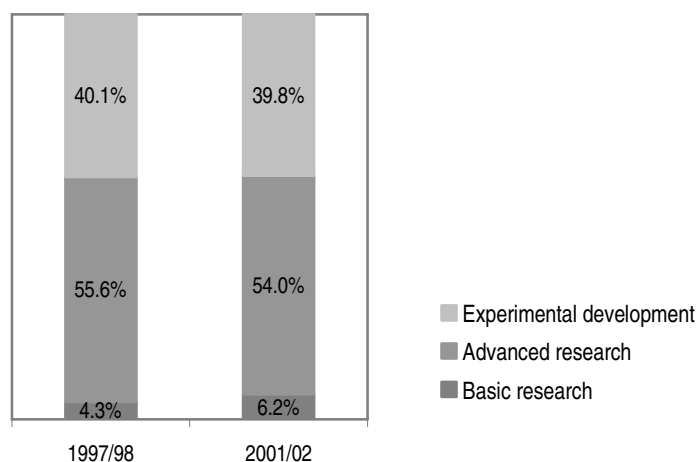
R&D expenditures	1997/98		2001/02	
	Mean (%)	Number of firms	Mean (%)	Number of firms
In-house	89.9	83	77.5	98
Third-party contractual R&D	10.1	83	22.5	98
of which <i>Kplus</i> (in % points)	n.a.	n.a.	(5.71)	(n=30)

3. For more details, see http://www.statistik.at/fachbereich_forschung/innovation_txt.shtml

In addition, the CIS3 data reveals that contractual R&D plays a prominent role for Austrian firms. Data indicate that *Kplus* industry partners spend far more money on external research than innovative non-participating firms do; in the year 2000 *Kplus* partnering firms spent on average one-and-a-half times more on external R&D than the non-participating innovative firms did.

With respect to the structure of R&D activities, no significant change could be detected during the period under investigation. On average, firms spent 40% of their total R&D expenditures for experimental development and about 55% for advanced research. The remaining part was invested in basic research (see Figure 4.1).

Figure 4.1. Nature of R&D activities of the *Kplus* partnering firms



Evidence on additionality can also be drawn from a comparison of the nature of R&D projects common to the firm and the R&D projects conducted in the framework of a public R&D programme. Therefore, one question focused on the differences between the common R&D activities of the *Kplus* business partners and the projects carried out within the competence centres. As seen in Figure 4.2, the majority of *Kplus* firms characterise the centre projects as technologically risky and more complex. Furthermore, the *Kplus* projects are longer-term, require higher levels of co-operation, and pursue more challenging aims. These findings indicate an added value resulting from the *Kplus* programme because usually the firms do not conduct such notable R&D projects. Moreover, most of the business partners consider that the projects carried out at the *Kplus* centres increase their expertise and do not focus that much on the market. Supposing that expertise and related competencies are only of value if they persist and develop over time, public funding might influence the strategies of the supported firms in the way that the partnering firms aim to continuously update their knowledge by collaborating with universities and research labs in the long run as well.

Figure 4.2. Quality of projects conducted in the *Kplus* centres

Compared to our business R&D activities, projects within *Kplus* centres are/do rather

...



The questionnaire also includes questions that directly relate to the objectives of the *Kplus* programme in order to assess their realisation. Since the *Kplus* programme aims at long-term co-operation, firms were also asked about the follow-up activities resulting from the participation in *Kplus*, the number of follow-up projects and total investments. Almost half of the responding firms stated that additional projects were executed in the respective *Kplus* centre during the firms' participation. Single business partners realised up to six follow-up projects, resulting in a total of 93 realised projects (n=51) and total private investments of about EUR 15 million (n=27).

Another objective of the *Kplus* programme is to increase Austria's opportunities to participate in international research programmes. Accordingly, firms were asked about their participation in the EU's fourth and fifth Framework Programme (FP). Table 4.3 illustrates that more firms are active and far more projects are realised in the 5th FP compared to FP4. On average a *Kplus* partnering firm received European funding for three projects in FP4, whereas in FP5 on average five projects were funded. *Kplus* partnering firms thus seem to benefit from the collaboration in the *Kplus* centres in view of the increase of successful applications for EU funding.

Having reviewed the characteristics of the participating firms and their R&D activities, our investigation turns to the reasons for participating in *Kplus* and the expectations of the industry partners. The partnering firms were asked to assess certain motives for participating in the programme on a five-point Likert scale. The relevance of several motivating factors is depicted in Figure 4.3. The most prominent reason for the involvement of private firms in *Kplus* centres is the "access to scientific or technological know-how". Other important reasons are the access to qualified personnel and the establishment of R&D alliances.

Table 4.3. Funding received from EU Framework Programmes

EU Framework Programmes	4th FP	5th FP	4th FP	5th FP
	Number of firms		Total projects	
Received EU funding	39	45	124	212
Did not receive EU funding	69	60	-	-
n.a.	10	13	-	-
Total	118	118	124	212

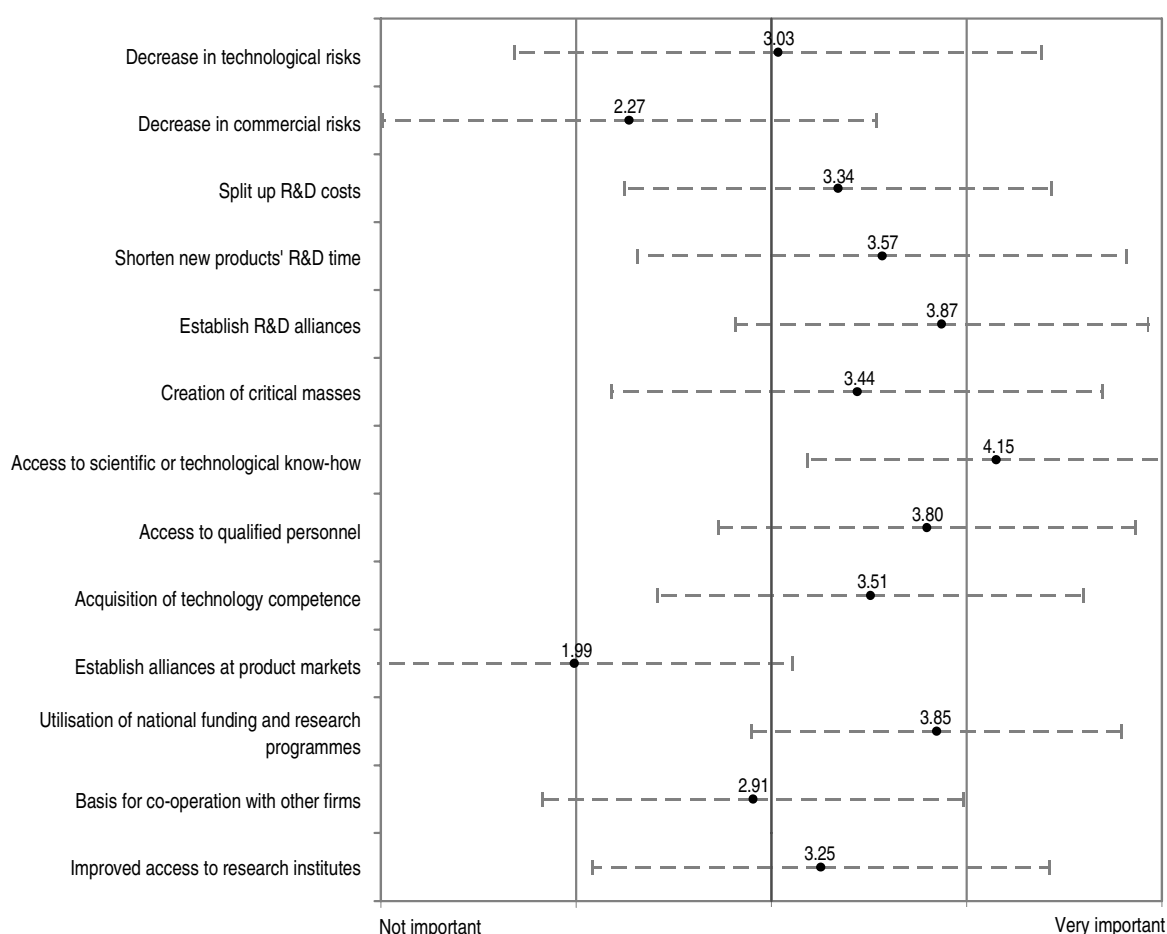
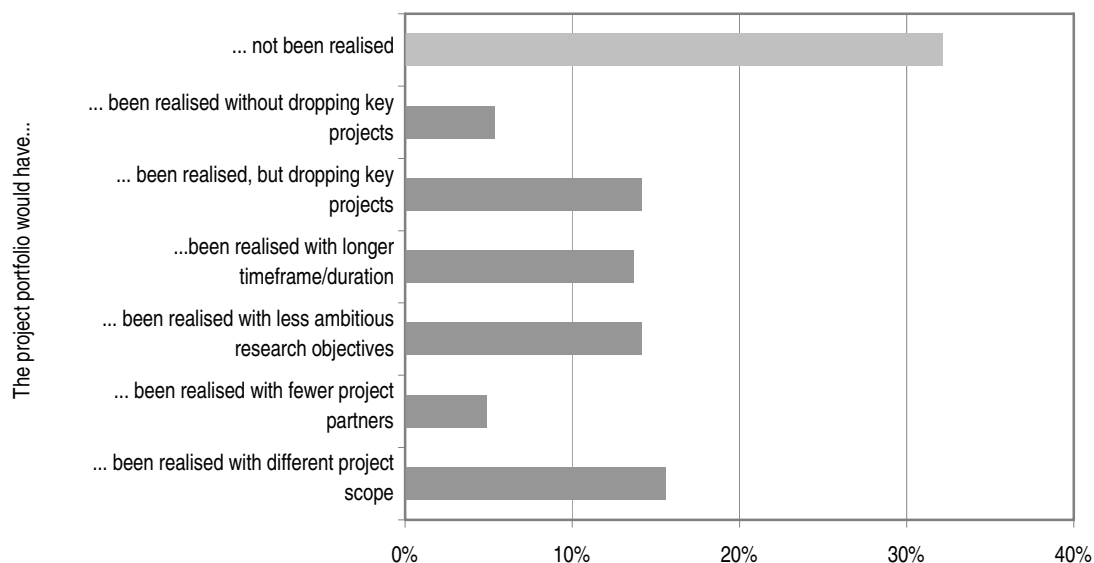
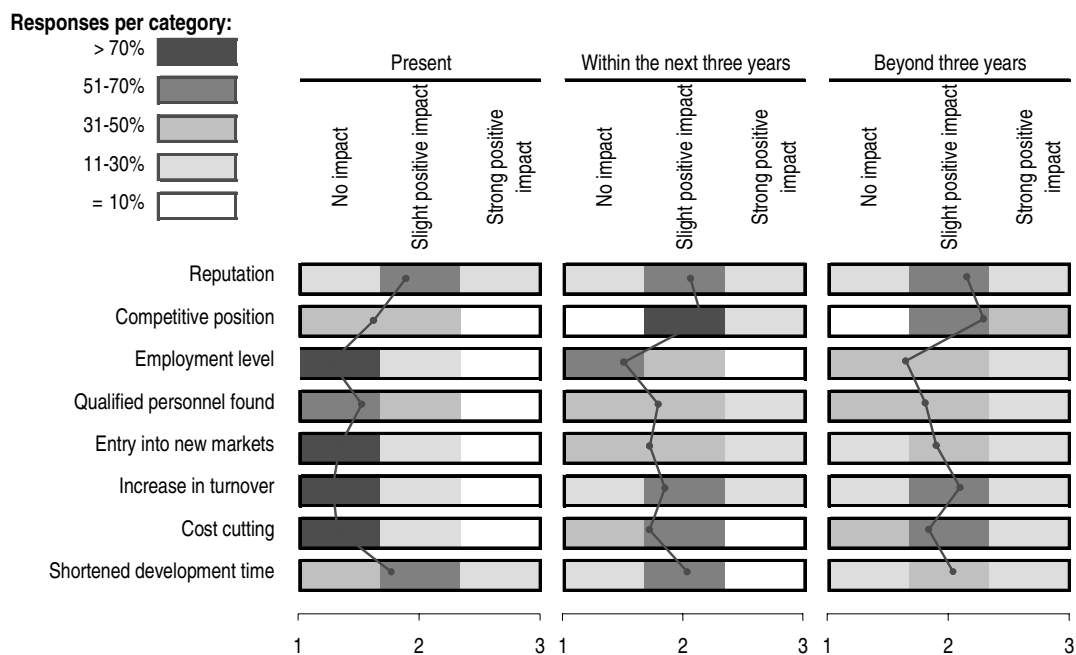
Figure 4.3. Motivating factors for participating in *Kplus* and its importance to firms

Figure 4.3 indicates that the utilisation of national funding and research programmes is an important motivation to participate in *Kplus*. Only 5% of firms replied that they would have carried out the projects without the respective competence centre. One-third of the firms, responding to a related question about the strategy that would be followed in the absence of the programme, stated they would not have been able to carry out the R&D projects at all (see Figure 4.4). The remaining *Kplus* partnering firms would have carried out the project portfolio but with limited resources, scaled-down objectives, and a different duration.

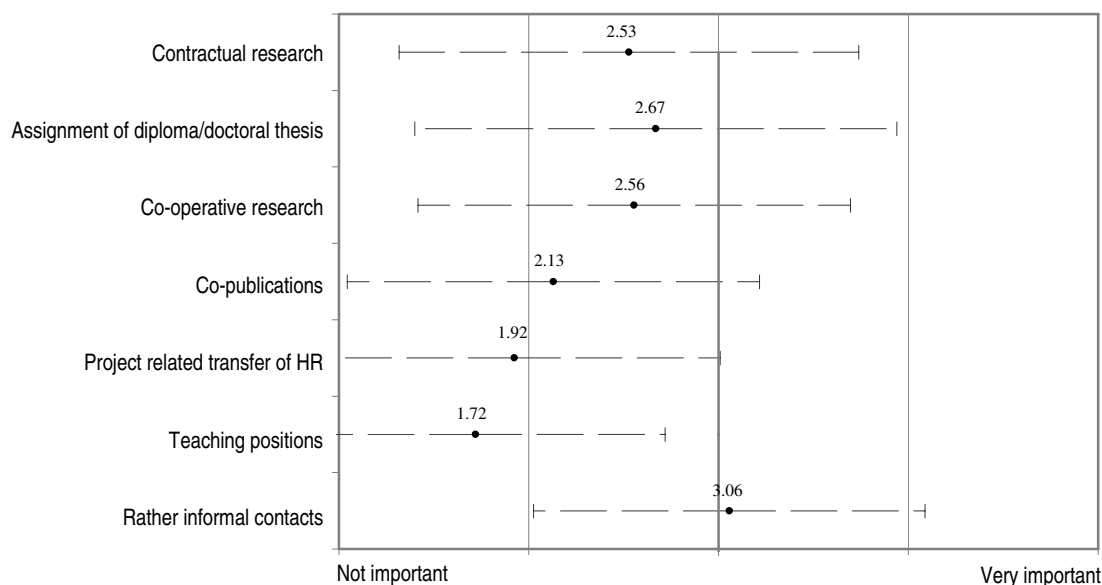
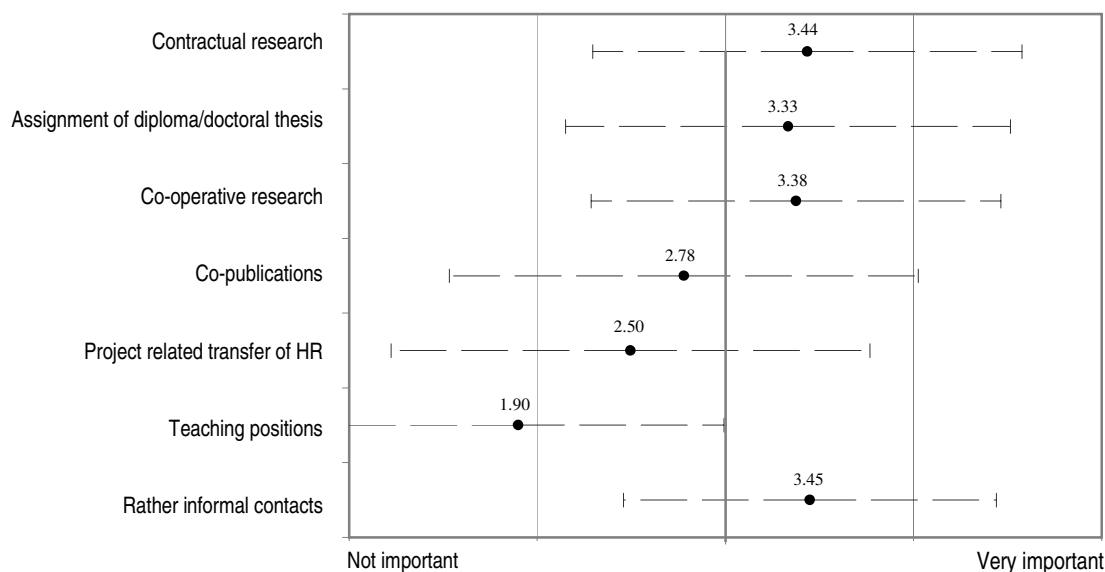
Figure 4.4. Strategy if the *Kplus* centre had not been created

Another question relates to the attained and expected impact of participation in *Kplus*. Firms had to rate the impact on several business parameters such as turnover, costs, reputation, etc., on a three-point rating scale for three points in time (present impacts, impacts within the next three years, impacts beyond three years). The results are shown in Figure 4.5. The line shows the average of all responses given. Shading reflects the distribution of the answers given by the *Kplus* firms in each category. Looking at the present impact on reputation, the chart shows that between 11% and 30% of the responding firms recognise no effect at all. Between 51% and 70% of partnering firms experienced some positive effects, whereas between 11% and 30% responded that participation had a strong impact on their reputation.

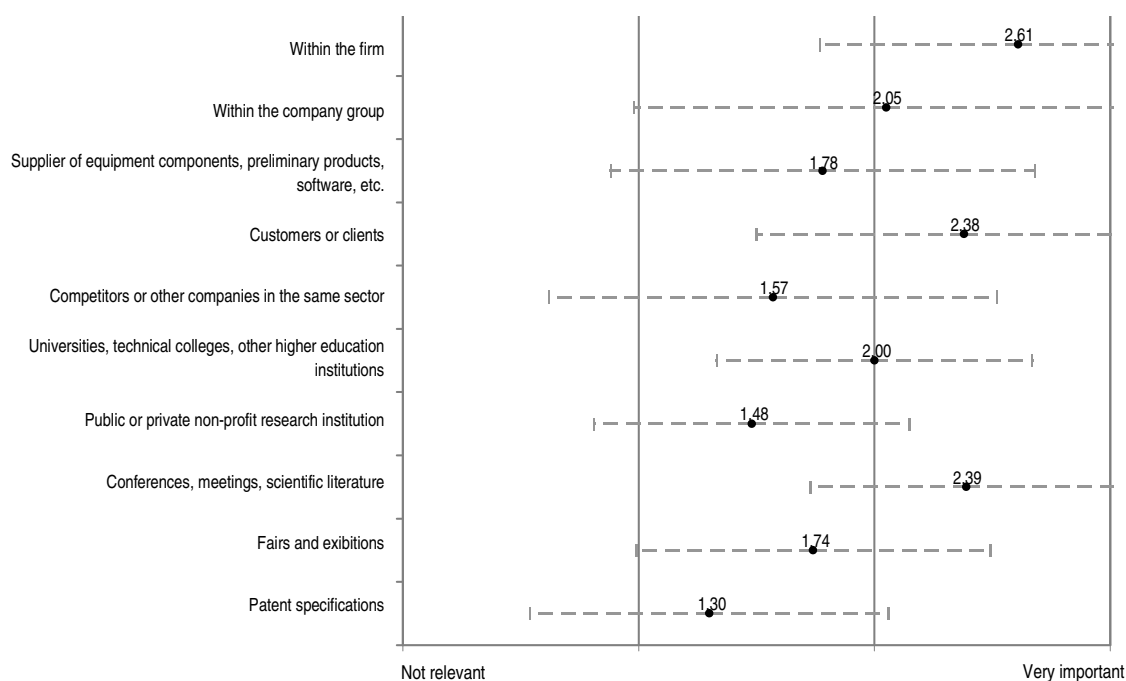
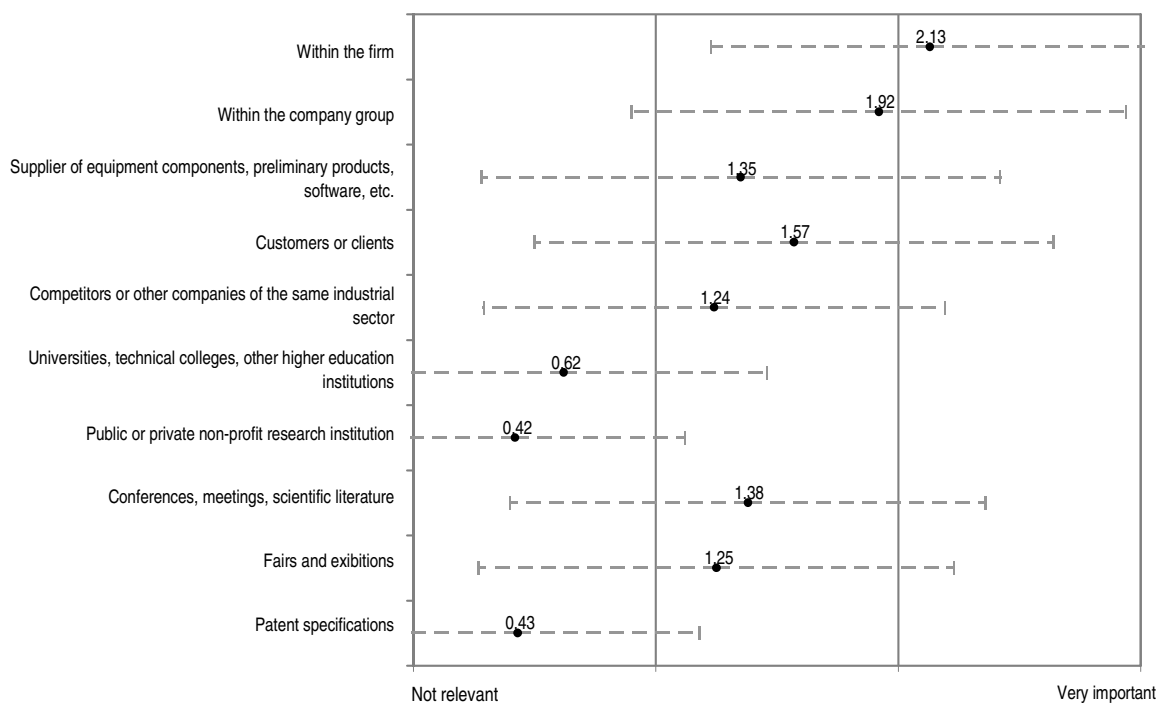
Overall, Figure 4.5 indicates that the majority of firms did not see an impact on most of the business parameters in question. The participation in *Kplus* only had a positive influence on their reputation as well as development time. Apparently, greater impacts are expected in the long run. More particularly, the expected positive impacts on the firms' reputations, their competitiveness, turnover and costs seem to be the main reasons to participate in the *Kplus* programme.

Figure 4.5. Impacts of *Kplus* on certain parameters of the participating firms

In terms of the behavioural additionality of the *Kplus* programme, which particularly aims at the improvement of the science-industry linkages, another important issue is the change in the firms' attitude towards the science sector. To gain insight, *Kplus* firms had to assess the importance of co-operative activities with universities and non-university research institutes on a five-point Likert scale. Co-operative activities included, for example, contractual research assigned to universities or other research institutes, or firms sponsoring master's thesis and/or dissertations and so forth. Companies were asked to evaluate the importance of each form of collaboration at two points in time (before the start of the *Kplus* programme and four years later). As shown in Figure 4.6, none of the forms of collaboration was of major importance to the firms before the programme started, whereas Figure 4.7 reveals that the assessment has changed during the firms' participation in *Kplus*. Each item, except for "sponsoring teaching positions" shows a statistically significant mean difference in the perception scores. These shifts to a higher level of importance suggest the changing attitude of business partners towards universities and research institutes, indicating that the *Kplus* programme induces positive behavioural effects.

Figure 4.6. *Kplus* firms' co-operation with universities and public research institutes in 1997/98Figure 4.7. *Kplus* firms' co-operation with universities and public research institutes in 2001/02

The increased importance of universities and public research institutes for *Kplus* firms is confirmed by the CIS data, which found *Kplus* firms collaborating with partners from universities or research institutes far more than the innovative non-*Kplus* firms. The same applies using universities and research institutes as sources of information for innovative activities. *Kplus* partnering firms perceive the public research institutes and universities as valuable sources for innovation activities whereas the non-participants rely more on other sources (see Figures 4.8 and 4.9).

Figure 4.8. Information sources for innovation activities of *Kplus* partnering firmsFigure 4.9. Information sources for innovation activities of innovative, non-*Kplus*-partnering firms

The main findings of the study, which aimed at revealing the impacts on the industry partners resulting from the *Kplus* programme, were presented above. The survey found evidence not only on behavioural additionality at firm level. Important results can be summarised as follows:

- One-third of responding firms would not have carried out the project portfolio without the *Kplus* programme. The majority of the remaining firms would have realised the project portfolio, but with limited project size, objectives or duration.
- In comparison to the firms' internal R&D, the projects conducted within the *Kplus* competence centres are higher-risk, technologically more complex, and longer-term.
- Universities and non-university research institutes in general gain considerably in importance for the partnering firm's innovation activities during the participation in *Kplus*.
- Follow-up projects with an estimated total investment of about EUR 15 million (n=27) were realised in the course of firms' participation in *Kplus*.
- The direct outcomes of *Kplus* for the industry partners predominantly consist of co-publications generated in the competence centres.
- The most important reasons to participate are access to scientific or technological know-how and qualified personnel, and the initiation of R&D alliances.
- The industry partners stated that by taking part in *Kplus* they have experienced certain positive effects with respect to the firms' reputation and shortening of development time. In the long run, the majority of firms expect positive effects for turnover, costs and their competitive position.

Concluding remarks

Measuring the additionality of policy interventions is a challenging task. The commonly used additionality concept, comprising input, output and behavioural additionality, is difficult to grasp. Its dimensions are dependent on time and often depend on each other. Even if additional effects are identified and measured, the causality is often questionable, *i.e.* observed effects do not necessarily result solely from the public intervention, and may not occur entirely within the investigated timeframe. Hence, empirical research often suffers from a time and attribution bias. The differences caused by public funding schemes in terms of behavioural additionality are also difficult to verify. The underlying aspects worth investigating, *e.g.* R&D-related strategies and the firm's attitude towards R&D collaboration and transfer activities, for example, are difficult to measure. The firm as such usually remains a "black box" particularly with respect to its R&D and innovation activities, the underlying decision-making processes, strategies and actions taken. Little is known about the actual interaction between policy intervention and firms' operations.

In accordance with the programme management, the impact on the industrial partners participating in the *Kplus* programme and differences in the firms' attitude towards science should be reviewed. The purpose of the study was quite challenging because it attempts to identify additional effects at the firm level resulting from a programme that addresses firms as "indirect beneficiaries" of public R&D funding. With respect to our research there are some limitations to the data set and the methodology applied. The concept of additionality and many of its fascinating aspects could not be covered in the

questionnaire, which was limited to 17 questions for practical reasons. So far, twelve competence centres have been analysed, supported by a small number of partnering firms (on average about ten firms per *Kplus* centre). The resulting sample size and the deviation of firms' characteristics restrict the research to rather descriptive analysis. Since the study did not exclusively focus on behavioural additionality, the sample is not detailed enough to investigate how internal firm factors might change the impact of the policy intervention. Apart from these limitations results of the analyses give empirical support for the existence of behavioural effects at firm level resulting from the Austrian *Kplus* competence centre programme.

To draw up robust conclusions, it is of major importance to have a data set that is large enough and contains reliable information. In practice however, firms are tired of filling out surveys and questionnaires. This causes a severe "data shortage" and limits the reliability of survey results. The concept of behavioural additionality primarily covers strategic aspects of R&D and innovation activities by firms. Supposing that firms are not willing to give insight into their strategic practices, the final specification of the behavioural additionality concept will take time. Further research is needed to better understand how the internal climate in firms (and in competence centres) actually influences the impact of public R&D funding on firms. Research -- especially empirical in nature -- is required, but is limited by the aforementioned difficulties. Whatever the "right" specification of the behavioural additionality concept might be, too much of what actually happens inside any firm and which influences the quality and quantity of realised R&D will remain unknown.

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Chapter 5

BEHAVIOURAL ADDITIONALITY OF THE R&D SUBSIDIES PROGRAMME OF IWT-FLANDERS (BELGIUM)

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Abstract. This chapter summarises an exploratory project to develop and implement an approach for measuring the behavioural additionality effects of R&D grants made to business by the Institute for Innovation by Science and Technology in Flanders (IWT-Flanders). The population of recipient firms was segmented into four groups: large R&D-intensive companies, large companies without permanent R&D activities, high-tech start-ups, and small and medium-sized enterprises (SMEs) without permanent R&D activities. For each of these segments, a tailored survey instrument (questionnaire) and research design (sampling and data collection method) was developed. The chapter reviews the lessons learned from the first exploratory research with this approach. The report concludes with an analysis of the cases that were included in the exploratory research and formulates suggestions concerning a full-scale evaluation to be conducted in Spring 2006.

Introduction

The objective of this study was to develop and test a methodology and data collection instrument for evaluating the impact of financial R&D grants with respect to behavioural additionality. The scope of the study is limited to *direct financial R&D grants*^{1,2}. The research design and methodology developed in this exercise are seen as a complement to the econometric studies that examine quantitatively the question of additonality versus substitution effects. Its goal is threefold: 1) to provide the policy maker with a more detailed insight into why and how companies apply for R&D grants; 2) to indicate and measure what the additionality in terms of input and output of these grants has been, given the innovation process within the company, and 3) to look at how they possibly have changed the organisation processes and strategies. The concept of behavioural additionality is used to uncover this “black box”.

1. See Georghiou (2003) for a positioning of R&D grants in a broader innovation policy environment.
2. This research refers to a broader research agenda that is discussed at the level of the OECD Working Party on Innovation and Technology Policy (TIP). Several research groups in different countries are setting up a research programme to evaluate additionality under the OECD umbrella.

For this reason, a specific survey instrument was elaborated. The survey instrument is complementary to the existing R&D survey and the Community Innovation Survey, which measure input and output of R&D and innovation processes, but not at the project or programme level. The latter is more interesting for an impact analysis since R&D grants are attributed at that level. In addition, the survey data can be used to enrich the econometric studies which are as of today limited to a small number of company level variables.

Behavioural additionality

In elaborating the behavioural additionality concept two major questions appear: *i)* What are its levels and its dimensions? and *ii)* When is a behavioural effect truly additional? Table 5.1 uses a categorisation of levels of behavioural effects proposed by Jari Romanainen of TEKES, Finland. The idea is that the effect on behaviour could vary according to three dimensions: *the organisation level that it is initiated, the duration and timing of the effect and its scope.*

This study distinguishes two main organisation levels. Level one is the strategic level. It is related to the overall direction of the firm. Level two is the operational level. It is interpreted as referring to management capabilities for implementing a strategy. Short-term effects are normally manifested during the life of the project. The long-term effects or sustainable/persistent effects refer to acquired competences. In terms of scope the project level and the company level are distinguished.

Table 5.1. Levels and sustainability of behavioural effects

	Project level effect	Company level effect
Strategy	<i>Example:</i> ST: Project in new business area for firm LT: New market alliance	<i>Example:</i> ST: Developing capabilities in new business/market LT: Joint venture or supply chain arrangement SME shift from contract research to manufacturing
Operation	<i>Example:</i> ST: New project reporting procedures to comply with monitoring requirements	<i>Example:</i> LT: Acquisition of management capability for collaborative projects

Note: ST and LT stand for short term and long term.

Focusing on the behavioural effects at the strategy level, many possible dimensions can be identified.

- *Knowledge acquisition* includes issues of how R&D is organised within the firm, for example corporate versus business-level R&D and linkages between them. In some cases corporate R&D is sustained because of the cumulative effects of public funding. Location decisions about R&D, including international ones, may also be influenced by technology policies (see also capital investment below).
- *Human resources* can be a direct aim of technology policy, as with schemes that subsidise the hiring of researchers, or an indirect result as in the case of a company's researchers upgrading their skills or qualifications within the context of a funded project. Management skills can also be acquired as a result of taking part in a project. Examples from past evaluations include SMEs learning about control procedures through compliance with planning and monitoring requirements demanded by a funding agency, or large firms using international collaborative

projects as a means of training managers in internationalisation skills. These acquired competences can be significant for future firm performance.

- *Capital investment strategy* is not at first sight a behavioural issue but it is possible that R&D support may influence the location of a company's facilities or even an entire laboratory, with long-term consequences for the region concerned and for the company's future networking. The support may also induce a firm to acquire equipment that it would not otherwise have, and as a result move in a different direction or in some cases the same direction more quickly.
- *Market position* is another area of possible influence. R&D may make a follower into a leader, on the basis of new processes for example. The innovative project may also introduce firms to new customers or to new markets. These may extend to products and services other than those initially supported.
- *Manufacturing strategy or strategy for service provision* may also evolve in the context of public support. This could be directly as a result of a process-oriented project or arise indirectly because the advance in a firm's knowledge enables it to change its production or service delivery methods. An example could be increasing use of e-commerce to reduce inventories.
- *Corporate responsibility and sustainability* can be an explicit aim of a project or form a further type of externality. For example innovative activity may result in reduced use of material or energy inputs and in turn may stimulate reorganisation within the firm to take advantage of this.

The big question in the additionality debate is whether these behavioural effects are additional or would have occurred also without the public support. In other words it is whether the perceived behavioural effects of government subsidies are additional to effects of venture capital or other private funding. It is evident that an approach to measure behavioural additionality of R&D grants should consider the different dimensions that characterise additionality as a concept. However, separating the additionality part in these effects – what makes the difference – is an additional challenge. The prevalence of behavioural additionality effects of government subsidies can be derived from observing behavioural changes over time within a firm or from behavioural differences between firms that received R&D support and peers that did not receive public support.

Population and sample frame

An assumption made in much of the econometric work is that the innovation process and behaviour are not different among the companies that receive R&D support. At most, size is introduced as a control variable to look whether small firms benefit more from the R&D support than larger ones. However, in practice R&D granting agencies such as the IWT make a clear distinction between different groups of companies in terms of their type. In fact, most European funding agencies have developed since the mid-nineties a specific track of programmes addressed towards SMEs. In addition, a number of agencies such as ANVAR, Sitra and Enterprise Ireland have developed specific activities oriented towards high-tech start-ups. Finally, some agencies such as FFF and DTI have developed R&D programmes to support companies in industries that are not R&D-intensive.

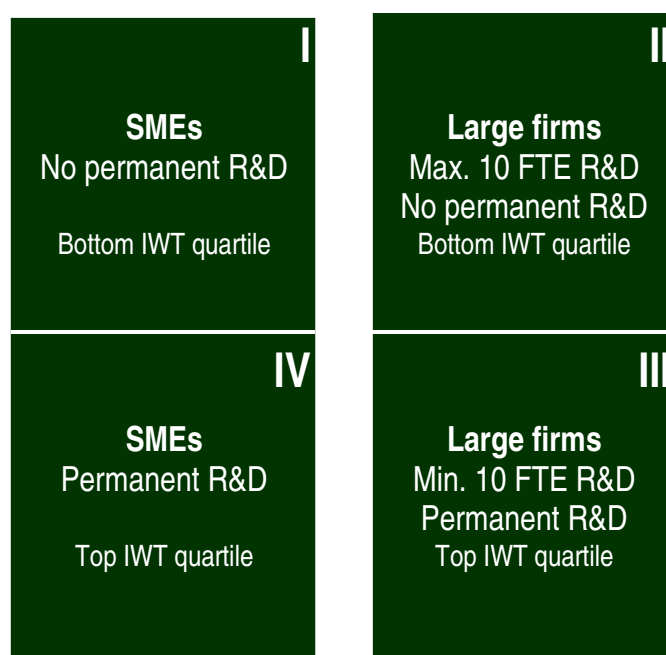
The main aim of this research is to enter the black box of company behaviour with regard to applying for and reacting on subsidies. To reveal potential differences in decision processes and in order to capture these in an optimal way, the IWT population was stratified according to the basic dimensions that determine their innovation strategy: size and R&D intensity.

The population of companies that received grants was segmented into four different groups that correspond to four different policy-driven sets of grant conditions (see Figure 5.1). Group I is the more traditional SMEs, which might be interested to innovate but for whom technology is not the core competence. Group II contains the large companies without permanent R&D activities, which only perform R&D at an irregular or low-level basis. The main driver for innovation in their industry is not technology. Among them, are companies in the fast-moving consumer goods where market research instead of technology has traditionally been the main driver. However, sometimes these companies undertake R&D projects in order to standardise their production process or to gain market share, *e.g.* through changes in packaging. If one looks at the statistics about gazelle companies, then it would be found that the fastest-growing companies belong mostly to this group. Group III contains the large companies for which the driver of growth and sustainable competitive advantage is technology. By definition, they have large R&D departments. They are the companies that tend to fill the top rankings in terms of R&D intensity. Group IV contains the SMEs with permanent ongoing R&D activities. They are often known as high-tech start-ups or new technology-based firms.

Because each of these groups differs in number of companies included *and* number of projects performed at the IWT, the study did not use a random selection of companies. This would result in an overrepresentation of SMEs, which outnumber by far the large firms. Therefore, specific companies were selected in each of the different segments. If the hypothesis is right that companies with different profiles experience different forms of additionality, then it was – at this exploratory stage – important that a heterogeneous group of companies be included companies in the sample. As outlined above, one of the important aims of this project was to formulate a set of questions, which captured different forms of additionality outcomes. Therefore, companies were selected among those that were situated in the top and bottom quartiles of the four groups. This was intended to provoke as many different forms of additionality as possible in the interviews. In practice, the selection process meant for instance that in the group of SMEs with permanent R&D activities, only those that were in the top quartile of companies having projects running at the IWT were selected.

Figure 5.1 shows the criteria used to select companies in each of the boxes. The list of all IWT clients as was compared with the sample frame of all companies that responded to the 1998 and 2000 R&D survey. The companies to be included in the research were selected based upon three criteria: 1) the fact whether they were officially considered as an SME or not (based upon the European definition); 2) their R&D activities; and 3) the number of R&D projects within these companies that had been sponsored by the IWT. In order to have clear-cut cases, companies were selected from those in the upper quartile of subsidies in numbers of R&D projects and those that were in the bottom quartile. The companies selected for the test interviews were well distributed among the four groups of IWT clients. Only the group of SMEs without permanent R&D activities was slightly larger than the other groups. However, also in the sample frame of IWT clients, this appears to be the largest group.

Figure 5.1. Segmentation of the target population



Questionnaire

A questionnaire was developed taking the preliminary work of Georghiou (2003) as a starting point. The survey model was elaborated and refined during the process. Although in the beginning of the process tailor-made questionnaires were developed in order to capture the information on additionality in an optimal way for each of the groups, one basic questionnaire was eventually produced for all four groups, with one additional module for the large R&D-intensive firms. The questionnaire was set-up in several modules. The basic unit of observation is the project level. For small firms and large firms with one or a few subsidised projects we found that the project level virtually coincided with the firm level. However, for large R&D-intensive firms with a large portfolio of grant-funded projects, it was found useful to have a separate module that provided information at the company level and that helped to provide contextual information for the project-level data. Table 5.2 gives an overview of the different modules of each questionnaire and shows the degree of similarity.

Part 1 of the questionnaire contains the general information about the company. This part overlaps with the R&D survey and can be extracted from that survey if the company filled in the questionnaire properly. The information from Part 1 allows a linking of the additionality results with the characteristics of the company such as size, export orientation, ownership.

Table 5.2. Questionnaire structure

Modules	No permanent R&D activities		Permanent R&D activities		
	SMEs	Large	High-tech start-ups	Large firms	
				In-take interview	Project interview
Group	I	II	IV	III	
1. General information about the firm	=	=	=	=	=
2. Competitive market position	=	=	=	=	
3. R&D budget, grants and personnel	=	=	=	=	
4. Description of the project	=	=	= ⁽¹⁾	=	
5. Project development process and organisation	=	=	=	Innovation portfolio	=
6. Project output, results and impact	=	=	=	Innovation output	=

Note: The equal sign (=) means that the content of that part of the questionnaire is similar to that of the questionnaire for the firms without permanent R&D activities.

1. The project level basically corresponds to the company level.

Part 2 of the questionnaire asks for information concerning the different product groups, which the company has both at the moment of interview and at the moment that it started receiving IWT grants. Firms were subsequently asked to which of these product categories the IWT grants were most closely related. For the selected product category the survey inquires about the competitive position of the firm. This allows analysis of:

- Whether the projects subsidised in the past are embodied in products that are still sold today. These projects can be both related to the development of these products or to the improvement of their production processes.
- Whether projects subsidised in the past are embodied in product categories where the company has today a monopoly-like position or where it is involved in fierce competition. We might assume that really innovative products lead to monopoly like situations and high value added, while marginal improvements often only extend the life cycle of the product in a competitive market.
- Whether the projects subsidised in the past are currently introduced onto markets that are growing, declining or mature. Again this could give us an insight in the effects of subsidies on these companies. If markets are still growing, the valorisation of the subsidies will be automatic and large. If markets are mature or declining, the subsidy might have been crucial for the company's survival on the market-place.

It is important to emphasise that this part of the questionnaire does not ask directly for the effects of the subsidised projects. Rather it allows respondents to describe the current situation on the product market for which a subsidy was claimed. Indirectly, this is informative for evaluating the output additionality.

Part 3 of the questionnaire deals with the R&D budget which the company has, the way this R&D budget is fixed (*e.g.* as a percentage of turnover) and the share of the IWT-subsidies in its R&D budget during the years for which they received IWT support. The most important section here is about the way the R&D budget is fixed. The other – descriptive – sections of Part 3 overlap with the R&D survey and can be extracted from that survey, if properly filled in by the company. However, having an insight in the way the size of the R&D budget is determined allows a determination of whether R&D grants

can have a lot of input additionality or not. Again, this is not asked directly in the questionnaire but the respondent has an opportunity to talk about it.

Part 4 provides general information about the project(s) that have been subsidised. More particularly, a link is made between the project undertaken and the core competence of the company. Information is also gathered about the origin of the funded project(s). Finally, respondents are asked to classify the project in terms of marketing impact and technology type. This allows a classification of the project(s) along the lines of Wheelwright and Clark (1993) as breakthrough, platform, derivatives or product support projects. This typology can be helpful in analyzing different additionality profiles.

Part 5 includes questions about the project development process and organization. More specifically, the contacts with the IWT during the contract preparation and project follow-up phase are linked to specific learning opportunities at the company site. In addition, several questions are asked to gain a view on the R&D strategy and the project decision cycles at the company, *e.g.* who is involved in making these decisions? Again this allows analysis of additionality in terms of differences in organisational characteristics.

Part 6 of the questionnaire measures the project output, results and impacts. In this part the traditional output indicators are discussed such as patents and percentage new product sales. The questions in Part 6 are classified into two main categories: 1) *project level effects and outcomes*, and 2) *possible company level effects*. Examples of project level outputs are questions such as: ‘*Did the project result in a new or improved product that is currently commercialised*’, or ‘*Did the project result in an improvement of your production process?*’ The second part asks questions concerning possible company level effects. Examples of such questions are: ‘*What was the impact of the new products and processes that have been developed with the help of IWT subsidies on your company’s: product/service supply, market share, product/service quality, production process, profitability, competitiveness, enterprise image, future innovation potential?*’ These questions do measure output, input and behavioural additionality. Table 5.3 summarises the different input, output and behavioural additionality indicators, which are collated in the core questionnaire.

Table 5.3. Questions classified according to behavioural, input and output additionality

Output additionality		New products on the market, new patents, market share, profitability	
Behavioural additionality		Project level	Company level
	Strategy	▪ Additional external finance (loans VC) ▪ Strategic partners ▪ Slack	▪ Improvement of production process ▪ Change patent strategy ▪ Competitiveness ▪ Image ▪ Future innovation potential ▪ Location of R&D facilities ▪ Enter a new technological domain
	Operation	▪ Product quality ▪ Faster development time ▪ Collaboration ▪ Larger scale ▪ Higher risk/return projects	▪ Indirect benefit to other department and business units ▪ Positive service/supply of product ▪ Formalised innovation process ▪ Better innovation management capabilities ▪ Prolonged collaboration ▪ Upgrade of human resources/research equipment
Input additionality		Increase in R&D budget	

Case selection and first results

Group 1: SMEs without permanent R&D

Selection of cases

In the group of SMEs without permanent R&D activities, seven companies were interviewed. The interviewed companies were heterogeneous in many respects, especially in terms of sector. The companies were active in different fields like carpets and furniture clothes, bakery machinery, sun protection systems, environmental technology engineering and system building, software for composite material applications, bio-energy production and electronic processing applications. Their average sales ranged from zero to about EUR 11 million with an average of EUR 3.7 million³. On average they export a little more than 50% of their sales, with two companies exporting more than 90% of their sales. Also in terms of employment size, there were large differences ranging from 0 up to 75 employees. The average company had about 22 employees. None of the companies is part of a larger group.

The firms interviewed turned out to be very different also in terms of R&D budget and personnel. While all of them were supposed to have no permanent R&D activities, two of them indicated R&D outlays of more than 30% of turnover. In absolute terms, R&D outlays ranged from EUR 25 000 a year up to nearly EUR 1 million. Also, while for the sample as a whole the median number of R&D personnel was zero, the average number was 2.6 FTE R&D personnel. Nevertheless, they all had only one R&D project that received an IWT grant. Two of them, the ones with the highest R&D-expenditures, were also involved in other publicly financed R&D projects.

Research design

Research on these firms typically followed a *two-step* procedure.

- *Step 1.* In most cases, there was first a contact with the IWT officials that dealt with the particular company. They gave a short introduction into the set-up and the content of the project as well as about the company. This introduction is extremely useful to put the project in a broader perspective and to have a door opener, catching the attention at the start of the interview. Where no such introduction by the IWT official took place, this general background information had to be requested from the company respondent, which made the interview a little longer.
- *Step 2.* In nearly all cases, the interview took place with the managing director of the company. Within this group of SMEs without permanent R&D activities, they turned out in most cases to be best informed about the project. But since they are very busy with the day-to-day management of the company, they were in some cases difficult to reach. Also, because they had only one project sponsored by IWT, they felt less obliged to co-operate in this evaluation research, as compared to the regular clients of IWT.

3. One of the companies interviewed still has to start its activities and therefore does not yet realise any turn-over or employ any people.

Four of them were interviewed face-to-face. The interview with the three other firms took place over the phone in order to explore the advantages and disadvantages of this approach for the full-scale evaluation in the future. When the interview took place over the phone, the questionnaire was sent beforehand. The goal was not to have it completed by the respondent by the time of the interview, but to have it available during the interview itself for easy reference. Our respondents afterwards indicated that indeed it was necessary to have the questionnaire available during the telephone interview because of the complexity of the themes covered. A trained interviewer is a better guarantee for a more consistent coding and reporting of the answers.

Learning experiences and suggestions for the full scale evaluation exercise

As indicated before, the group of companies interviewed was heterogeneous and probably much more heterogeneous when compared to the other quartiles. This implies that the following results are preliminary. In terms of the best interview approach, face-to-face or by telephone, no clear conclusion arises. A final decision will probably depend on the available budget for the full-scale research since face-to-face interviews are much more time consuming. A postal survey is no option because of the complexity of the themes covered.

In most of the companies interviewed, R&D is not a well-structured, formalised activity since these companies have no strong technology driver. For these companies, R&D costs time and money that are not always available. Someone working on a R&D-project is no longer available for other tasks. Therefore, one of the most important additionality effects mentioned by the interviewed companies, is the simple fact that the IWT support allows the companies to let someone dedicate most of his or her time to an R&D project, not being disturbed for other production related activities.

A *behavioural additionality* effect, mentioned by all of the interviewed companies, is formalization of the innovation process and/or increased innovation management capabilities within the firms. In one case, the IWT project resulted in the set-up of a separate R&D department. In several other cases, the requirements of IWT led to a more structured way of planning and reporting about the R&D activities. Compared to the outcome of the project without IWT grant, the project has been undertaken faster and on a larger scale. Most companies also mentioned the fact that the project caused their company to undertake higher risk research than would otherwise be the case and increased their ability to network with other firms and/or universities or public laboratories.

No clear tendencies show up with respect to the type of project in terms of marketing impact. However, in terms of technology, projects are either incremental, *i.e.* extending existing technologies beyond the normal operating window, or next generation, *i.e.* pushing existing technologies into a completely different operating window. In some cases, what appeared to the firm as a next-generation project was in the interviewer's opinion an incremental project. It is not a surprise that none of the respondents qualified its project as radical in terms of technology. For the full-scale evaluation exercise, we plan to ask the IWT officials also to classify the project in terms of market and technological uniqueness. Although the respondents are asked to do this as well, their reference frame is smaller or different at least. Not surprisingly, this results in a different perception of radicalness.

Two of the interviewed companies turned out to have permanent R&D activities and were therefore inaccurately classified beforehand. This experience makes it very clear that in practice a reclassification can be necessary before analysing the data in depth.

Group 2: large non-R&D-intensive companies

Selection of cases

In the group of large non-R&D-intensive companies, two cases were selected for further exploration. As in the previous group, the cases were chosen in two completely different sectors and they had a different holding structure. Case 1 was an aluminium and steel company founded in the mid-20th century. Being a company in a rather traditional industry, it had to specialise in terms of market approach and know-how. Although the company is active in an industry which requires quite some technical knowledge and technology, it has no R&D department to speak of. It counts about 220 employees. Since 1991, the company had only one project subsidised by the IWT. Case 2 is a typical family-owned company, active in the field of food processing. Being an SME for many years, it really became a multinational in the eighties. Its main focus remains in Europe however, where it is a market leader for prepared meals. Although the company is active in fast moving consumer goods where R&D has traditionally not been a main driver of growth and competitive advantage, it has an R&D department with 6 employees. Like in many non-R&D-intensive companies, eighty percent of their time goes to quality control. Very little time is left for technology scouting, not to speak of technology development. The company was involved in 11 projects as a (non-funded) partner and had received money for 1 project.

Research design

The research design followed is similar to the one adopted in the previous group. Also the questionnaire is identical to the one used for the first group of non-R&D-intensive SMEs.

Learning experiences and suggestions for the full scale evaluation exercise

These companies clearly have no technology driver. Case 1 had a production driver. This means the company makes money and even grows because it can produce the same material cheaper and in a more flexible way than its competitors. This production can not easily be moved to cheap labour countries because the industry requires quite some tacit knowledge. This cumulated production experience is the main core of the company. Case 2 has more of a market driver. Product positioning and branding has become key in fast moving consumer goods to increase market share. Because the main driver to make money in these industries is not a technology one, the decision to get involved in R&D projects or even ask for public financing remains usually peripheral to the company's core strategy.

A (lack of) behavioural additionality, which was mentioned by both companies, is the fact that the current system of R&D grants is too marginal for them to have an impact on the strategic decision makers in the company. Despite the fact that at a project level, the impact was clear and distinctive, the subsidy component is so marginal that the responsible person can never use this as an argument to increase the company's involvement in long-term R&D projects. Because R&D was not of strategic importance to company growth and innovation, asking for R&D subsidies is not a strategic choice for

these companies. It is inspired by demands of clients or subcontractors or it is the result of the initiative of an inspired individual.

Both companies had no fixed budget for R&D nor a clear decision structure to determine how much has to be spent on R&D. In addition, the subcritical mass in R&D made it difficult for them to attract good people to perform the R&D projects. The subsidy did not really change this problem because it was only a small part of the total amount of the project that got subsidised (usually a maximum of 25%). Because these companies were not SMEs they could not benefit from the dedicated SME programmes, which subsidise up to 50% and grant loans up to 80% of the project size. In addition, the project caused extra administrative costs so that the net result was perceived to be much less than 25% (after taxes, in the best case).

Although behavioural additionality is difficult to identify at the company level, some aspects of behavioural additionality emerge at the project level. Both companies changed their specifications as a result of the project. This improved both their final production system or the product in itself. As such, the project was evaluated to have had positive and sustained results. There is only a small amount of input additionality in the two cases because the project did not result into an increase in number of R&D persons employed nor did it increase the overall R&D budget. This relatively small impact can be explained by the different strategic drivers, which these companies have. Technology is considered to be an enabler in function of the core strategy. As such, permanent investments in R&D usually take the form of quality control and very little slack time remains in the company to devote to new product development or outside-the-box thinking. Also the amount of output additionality of the subsidised projects stays quite low. Since the company performance is only slightly affected by its R&D results, direct output additionality is difficult if not impossible to trace back.

In both cases, the subsidised R&D was a result of partnerships. It seems that for this group collective R&D programmes are quite important. Further, R&D subsidies are quite limited to technology development. However, because these companies rather use enabling technologies to improve their products instead of developing technologies themselves, it means that public R&D support could be more oriented towards technology watch and joint technology scouting activities. Often the absorptive capacity in these firms is lacking to recognise and adopt new technological changes from supplying industries such as for instance the packaging industry for food processing or from client industries such as the high speed trains for enriched steel cables.

Group 3: large R&D-intensive companies

Selection of cases

In the group of large R&D-intensive companies, three cases were chosen in this exploratory phase to explore into more depth. The cases were chosen to differ in terms of sector, holding structure and amount of subsidies received. Case 1 was a biotech company founded in the early eighties. Being a high-tech start-up and a spin-out from a university department, it was a remarkable company. It was one of the few companies in Belgium that succeeded then to obtain a significant amount of venture capital. In 1995, the company was introduced on NASDAQ and boosted in terms of employees. It counts about 550 employees worldwide and is active in the field of theragnostics. It has received a substantial amount of subsidies since the inception of the IWT in 1991. Case 2 is a software company founded in the seventies. Although it was founded as a spin-out of a local university, it

did not stay independent for a long time. It was taken over by a Flemish multinational in the mid-1980s. It was taken over by an electronics company, while being a software company. It grew to over 500 employees, but a couple of years ago the company was split. Part of it was sold to a Danish multinational. In total, the company received over EUR 5 million of subsidies in R&D since 1991. In a third case, the take-in interview was performed.

Research design

For this group of companies, the research design involves a *three-step* approach.

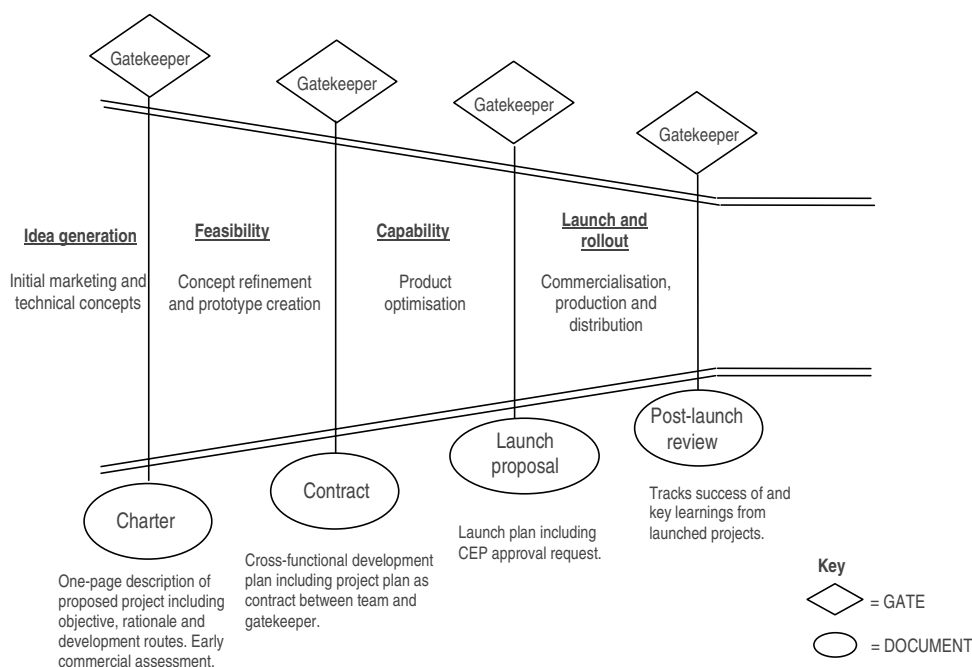
- *Step 1.* Contact was made with the responsible IWT officials that dealt with the particular company. They have excellent – privileged witness – information about the project and the company. The projects were overlooked with each of these officials and the most interesting ones were discussed in greater detail for further analysis. This step is similar to step one followed in the previous two groups.
- *Step 2.* A personal visit was made with the R&D manager of the company for the in-take interview. The main goal of this interview was to disentangle the innovation process and analyse at which stage in this process, subsidies were claimed. Rather than focusing on one particular project, the discussion focused on the portfolio of projects.
- *Step 3.* Interviews were held concerning specific projects with the responsible project leaders. The questionnaire we used is called the project questionnaire. It is a shorter version of the main questionnaire with only Parts 1.5 and 6.

In order to structure this in-take interview we use a customised version of the questionnaire presented above. In short, the first three parts of the questionnaire remain about the same. These parts (see also Figure 5.3) relate to the general information about the firm, its competitive market position, its R&D budget and its business and innovation strategy. Part 4 of the in-take questionnaire is different from the core questionnaire discussed above and deals with the innovation process. In this part, we ask the respondent to describe the innovation process adopted in the company.

To structure the questions, a funnel presentation of an innovation process was used (Figure 5.2). This funnel presentation is not new. Several scholars in the R&D management literature have found that R&D-intensive companies try to structure their innovation process in such a way (see Wheelwright and Clark, 1993). The basic idea of the funnel is that each development of a new product is managed through milestones on which “go/no-go” decisions have to be made by a certain committee based on a write-out or a presentation of progress. Although the funnel itself tends to be general across companies, the go/no-go decision parameters and the people in the committees tend to be different.

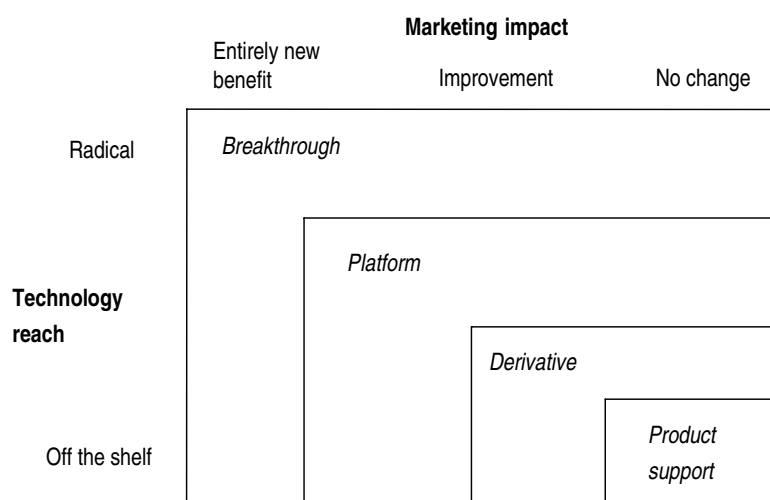
Interviewees were asked whether they recognise this funnel presentation and whether they could describe the different milestones and decision committees in their own company. They were also asked at which stages of the tunnel subsidies are requested. The basic idea behind this is to analyse whether subsidies are asked *after* a go/no-go decision is made or before. Since this stage of the interview did not aim to evaluate specific projects, the respondents do not seem to feel forced to give certain answers.

Figure 5.2. The innovation funnel



Source: Wheelwright and Clark (1993).

Part 5 of the in-take questionnaire is also different and deals with the innovation portfolio. Some projects are related to what is called pre-competitive research which targets totally new markets and technologies. Others have to do with marginal improvements of products into existing markets. This means that the lead time-to-market of these products will be very different and the results that can be expected from them as well. It is known that company lead times for pre-competitive research are 12-15 years on average before 2% of the maximum annual sales (the product will ever have) is reached. It is clear that in an evaluation many of the subsidies to pre-competitive research might not even have resulted into marketable products yet. On the other hand, product development cycles of marginally new products have shortened drastically. In some industries they are not more than three months, while in others it will be maximum one year. It is thus important to know how the projects for which subsidies are asked were positioned in this at the time of financing. Again, a well-developed and known framework presented by Wheelwright and Clark was used (see Figure 5.3). R&D managers were asked to position the projects on a quadrant, which allows a differentiation between breakthrough, platform, derivative and product support projects.

Figure 5.3. **Portfolio management**

Source: Wheelwright and Clark (1993).

Finally, specific questions were asked regarding the company's innovation output (Part 6 of the questionnaire). This part of the questionnaire is again very similar to the main questionnaire. But instead of linking these output questions to a specific project, they are related to the company: How many new products the company has introduced? Does the company have a patent strategy? This is important information for the next stage, namely the project questionnaire. If one of the results is that the project has generated at least one new patent, but the company has a clear and productive patent strategy, this is less valuable than if the project subsidised has resulted into a patent in a company which had no patent strategy to start from. The latter case shows a clear behavioural additionality, which might be long lasting.

Learning experiences and suggestions for the full scale evaluation exercise

Face-to-face interviewing seems to be an excellent technique of data collection to reconstruct the innovation process in these large companies. The R&D managers recognise their own company's procedures and capabilities in the funnel and can directly attribute milestones and committees to the funnel.

In terms of *behavioural additionality*, the results are remarkable. The large R&D-intensive companies that were interviewed answered that the decision to ask for project subsidies came *after* the go/no-go decision was made. Although the number is of course very small and not representative, this suggests that, among these companies, there will be a group for which the input, output and behavioural additionality at the project level will be limited, by definition. It also implies that the subsidies fit into a project portfolio but do not change any decision in the short run. Additionality can thus not be seen in such a linear, causal way as many econometric studies tend to suggest. Long-term effects were not investigated and can be quite different since expectations about the degree to which subsidies are taken for granted could change. The effects are also more likely at the level of project families than of single projects.

In these cases the IWT subsidies were managed by a person who is not a project leader or an R&D manager. The idea is to keep project leaders as much as possible away from the administrative part, which subsidies tend to evoke. This means that subsidised projects can hardly have any effects on the way of working in the company at project level. In two out of three companies, the responsible project officer at the company had longer experience than the one at the subsidising agency. Therefore the project officer felt he had to teach the administrators at the R&D granting institute how to deal with the projects.

Although behavioural additionality at the project level is difficult to identify, some additionality could be detected at the strategic level. One quote mentioned was that the availability of a steady stream of R&D subsidies was a good negotiation element to keep part of the development activities in Flanders. This might be explained by the very high personnel costs in Flanders. The R&D subsidies can be seen as a discount on the R&D personnel cost.

Additionality at the project level was found in terms of a wider project scope, as well as taking higher risk-return project options. In terms of timing, the respondents interviewed by us answered that the subsidies had a positive impact on the execution speed of the project. The flip side of this is illustrated by one company (out of the three) that decided because of the subsidies to continue following research avenues that proved to have little direct market value in the end. Without the subsidies this research would have been abandoned at an earlier stage. So in this case the know-how that had been generated could not be directly used for production and commercial purposes, although it turned out valuable in other projects and product developments later on.

Another project level additionality effect was the adaptation and use of more systematic documentation and accounting practices for both internal (inside the company) and external purposes. One company reported using the IWT reporting and assessment framework for dissemination of information on new projects inside the company and for decision making. The availability of R&D subsidies allows starting projects earlier. This was the case in the biotech sample, where capital is scarce. This quote might fit more the high-tech SME sample where a number of companies saw R&D subsidies as a complement to the venture capital they had received.

Group 4: R&D-intensive SMEs

Selection of cases

Among the R&D-intensive companies, ten cases were selected for further exploration. As in the previous cases, the companies were selected in order to maximise sectoral diversity. But still, four cases belonged to the IT sector. They were basically software development companies. At start-up, these companies had raised an average amount of capital of EUR 31 000. They employ on average about five employees. They were all founded in the last ten years. Three cases were selected in the medical-related industry. This industry includes both biotech companies and firms that develop medical equipment. The average capital they had raised at start-up was EUR 4.7 million and they employ on average 30 employees. The biopharmaceutical start-ups interviewed by us needed more money at start-up than the medical equipment company. Therefore, large differences existed in the starting size in terms of capital and persons employed. All three companies are university spin-offs. Finally, three companies can be classified into the

field of (micro-)electronics. They raised on average EUR 20 000 at start-up and employ on average seven people.

Research design

In these companies, the CEO or CTO (if available) was contacted. Usually those are also founder of the company. Although a one-step design was used in this exploratory phase; ideally a similar two-step design should be adopted as for the group of non-R&D-intensive SMEs. Part 1 and Part 2 of the questionnaire are similar to the core questionnaire for the non-R&D-intensive companies. Part 3 is adapted to the specific situation of the company. Usually, these companies do not have an official R&D budget. Instead, R&D is often a core activity next to business development and is paid out of their capital raised. As such, the questionnaire is customised to their situation. The questions in Part 4 concerning the management of the innovation process are skipped. Part 5 deals with the project portfolio. Usually these companies are one-project firms at start-ups. Rather than positioning the project within a larger portfolio, the company itself is positioned in the broader industry. Part 6 remains the same to the other questionnaires.

Learning experiences and suggestions for the full scale evaluation exercise

In these companies, the technology and business strategy are usually identical. Also, the project subsidised tends to be included in the core activities and strategy of the company. Therefore, R&D subsidies have a direct strategic input additionality. They are considered to be a complement to venture capital, which is necessary to let the company grow and prosper. In the absence of these R&D subsidies, at least the reliance on external financial sources would be greater and strategic autonomy of the founders smaller.

Behavioural additionality of the subsidised projects is very clear for these companies. Two out of three high-tech start-ups stated that receiving subsidies from the IWT had a positive, non negligible impact on the company's credibility and public relations towards potential clients, investors, and employees. It seems as if the IWT is used as a quality label. The receiving of an R&D grant means that they have successfully survived a due diligence performed by a neutral and qualified agency such as the IWT. Almost all R&D-intensive SMEs conclude that the subsidies have resulted into a more intensive form of collaboration and an increase in networking. At a project level, the subsidies either result into a larger project or into a project that is finished in a shorter time.

R&D subsidies have also a behavioural effect at strategic level. Often, these companies can adopt a business model which would not be allowed if they were (only) financed with venture capital. Academic scholars have shown that the most successful high-tech start-ups today are those which started with a service model. However, this model has traditionally not been very popular among the venture capitalists, which are mainly oriented towards quick and exponential growth. Neither does a service model render enough revenues and cash flow to pay for R&D.

In addition to the behavioural additionality, the *input additionality* is also obvious. R&D-intensive SMEs or high-tech start-ups usually suffer from capital constraints. The R&D subsidies serve to increase their financial leverage and allow them to build a long-term strategy. In half of the cases, the start-up would not exist anymore today if it had not received subsidies from the IWT. In most cases, the support it received served to realise its business plan strategy and eventually affected the competitive position of the company.

Analysis of the main results

Preliminary results across groups

Although the sample in this preliminary study is far too small to draw solid conclusions, it is interesting to map the results that came out of the interviews in the additionality grid shown in Table 5.4. As mentioned earlier, the target population was divided into four strata. Three types of additionality were distinguished: input, output and behavioural additionality.

Clear differences can be seen among the four quadrants in terms of additionality. For instance, among the group of large companies with permanent R&D, measuring input and output additionality turned out to be extremely difficult. The in-take interviews taught us that the companies that were interviewed had a standard innovation process. They applied for subsidies *after* milestone decisions had been taken and after a go for the project was received. This means that additionality at the project level is very difficult to measure in the short term. Furthermore several projects in one research programme received subsidies. It appeared that this programme and eventually business unit level seems to be the right unit of analysis to measure behavioural additionality in the long term.

But even at the programme level, input and output additionality seemed to remain weak. It is not that the size of the R&D budget changed as a result of the subsidies. One of the respondents answered that subsidies were seen as a reduction on the expensive R&D employment and that they became part of the locational advantages. Input additionality seemed to be less prominent. It remains to be investigated whether subsidies influence the portfolio composition when the go/no-go decision is linked to acceptance for subsidy. Also the output additionality was weak or at least extremely difficult to measure. In the three companies a separate administrative system was set up to manage the subsidy. The engineers and project leaders seemed to have relatively few contacts with the financing administration. Seniority of the IWT advisors seems to be a condition to help to identify additionalities at the programme level. On average the subsidy was less than 5% in the total R&D budget of the company. Therefore it is hard to allocate any direct effects to the subsidised project.

On the base of the questionnaire the behavioural additionality results were distinct and very visible. One company reported that it used the subsidies as a negotiation element with the foreign parent company. This means that there is a large opportunity cost associated with the availability of subsidies. If these mechanisms disappear, the subsidiary loses its negotiation power vis-à-vis the parent. A second element of behavioural additionality included the incentive which companies received to invest in riskier technologies through the subsidies. In fact, the R&D grant allowed them to defend a riskier research programme or to move in their project portfolio to somewhat more risky segments. However, it is important to note that this kind of decision was not made at a project level. Finally, it was observed that the large companies created a separate line of administration to organise the administrative follow-up of projects. In all the cases interviewed, a separate person was dedicated to this task. Although this kind of organisation might increase the overhead, it also increases professionalisation. This gatekeeper function might have interesting indirect spillovers to the team members working on the project.

For the large companies without R&D, additionality was clearest at the output level. The main driver of business growth can be production or market, but usually not technology. For instance, a company in the beer industry tends to make money through innovative branding and geographical diversification in the first place. Technological projects in these companies are usually supportive to the main business drivers. Input and behavioural additionality were much less clear for this group. Firstly, input additionality assumes that the R&D subsidy will lead to further and more investments in R&D. Often, we see that the R&D project was an *ad hoc* event. Since in these companies technology is not or has not been a strategic driver of growth, it is very difficult for the R&D manager to have a distinct impact on the overall strategy of the company. The subsidy, which he can get from the IWT is small (usually no more than 25%). As a result, the cost benefit (cost = additional administration), benefit (= 25% before taxes) becomes very small. Having an R&D grant is usually the result of a personal, individual based initiative or it is the result of the initiative taken by a supplier or lead customer. After the project has been finished the interest of the company to continue tends to disappear as well.

Financial grants, in the form they exist today (limited percentage, high administrative cost), are not the most efficient way to encourage these companies to get involved in R&D. Usually, the R&D function in the company is simply too peripheral to invest heavily in R&D. But the subsidies may lure those companies into collaborative projects that do have long-term effects on strategy. However, other kinds of technology-related activities such as technology scouting and market screening are interesting domains to investigate in. At this moment, there is no real support instrument for these initiatives.

Table 5.4. **Additionality results**

Large companies with permanent R&D			Large companies without R&D		
Input?	Output?	Behaviour	Input?	Output	Behaviour
		- Keep R&D in Flanders - Invest in riskier technologies - Develop project administration - Scale and scope		Productivity improvement	Co-operative projects
SMEs with permanent R&D			SMEs without permanent R&D		
Input	Output	Behaviour	Input	Output	Behaviour
- Co-finance of R&D - R&D ↑	Market share ↑	- Collaboration - Project management - Credibility ↑ - New business	Start R&D	New activities	Management

SMEs with permanent R&D activities seemed to benefit the most from the R&D grants. For these companies, input, output *and* behavioural additionality were clear and substantial. With respect to input additionality, the examined companies used R&D grants as an important source of financing for their R&D programme, but they also used it as a vehicle to gain credibility among their own stakeholders, usually venture capitalists or bankers.

In these firms there is also a considerable degree of output additionality. The high-tech start-ups in the sample all could increase their market position and competitive advantage. The subsidies functioned as a leverage mechanism. Their subsidy component was usually much higher than the one for the large companies. Currently, high-tech start-ups can receive up to 80% project financing under the form of subsidies and deferred loans. In addition, their credibility increased significantly once they had received the grant. Through this increased credibility, the companies were able to convince lead customers, which otherwise would not have come to the start-up.

Finally, the R&D grant also changed the company behaviour. In short, most high-tech start-ups mentioned that they were able to build up a network with local universities and technology service providers through these grants. These kinds of collaboration continued to exist after the grant was finished. Finally, several high-tech start-ups also reported to us that they had learned from the project management approach adopted by the IWT. It forced them to put milestones on the project and administratively follow up the project.

Preliminary results across additionality types

Although the sample at this point of the research is very small (25 firms) and selected in a non-random fashion, the summary made in the next three tables is interesting as a first indication of which indicators can be drawn from the questionnaire. From left to right, each column describes: 1) the question as is in the questionnaire; 2) the scale which is used (Likert scales are 1-to-5 scales); 3) the averages and medians of respondents; and 4) percentages of respondents.

Since the group of SMEs with and without R&D outnumber by far the rest of the population, this should be borne in mind when interpreting results. Hence, for what they are worth, they are most representative for these two groups. Moreover, since the exploratory phase consisted of questionnaire construction rather than implementation exercise, the number of questions, their exact wording and the formulation have changed over time. The summaries in the tables are a best attempt to analyse comparative questions.

Table 5.5 shows the impact that the subsidies are estimated to have had on the other resources used in the organisations. The main result suggested by the answers is that the project would only be undertaken at a smaller scale without the subsidies. In only 30% of the cases it would not have taken place. Almost three out of four companies also suggest that the project has resulted in positive attention for R&D after the project was finished. This means that either the company's R&D budget has increased or that R&D was considered as being (more) important. Not surprisingly, 90% of the respondents will in the future re-apply for a subsidy. The interviewed companies report that the subsidy adds up to 32% of their budget. This also indicates that these companies are SMEs.

Table 5.6 shows whether the subsidies have had any impact on the company's organisation. Grants are requested for projects with relatively high market and technical uncertainty. The companies interviewed consider the impact of the contacts (*e.g.* preparatory visit or contract management) as having little or no influence on the way the project was conducted. Neither did they consider the IWT advisors to have an impact on the way they collaborate with partners or the way they choose their partners.

Table 5.5. **Impact on input**

Input: resources	Scale	Average (median)	Percentage responding "yes"
Average share of IWT subsidies in total R&D outlays during years of receiving IWT grants	0 – 75	32% (20%)	
If the project would not have received IWT grants, it would have been financed with a smaller budget	0/1		46%
If the project would not have received IWT grants, it would not have taken place at all	0/1		29%
If the project would not have received IWT-grants, it would have been financed with the same budget	0/1		25%
Positive impact of the IWT grant on the evolution of the R&D budget after project finished	0/1		62,5%
The project that received IWT support allowed to improve/upgrade human resources	Likert	2.9 (3)	
The project that received IWT support reduced material or energy consumption with positive benefits for sustainability	Likert	2.3 (2)	
Planning to apply for a new IWT grant in the future	0/1		90%

Consistent with the results shown in Table 5.5, the respondents find that the project could be undertaken faster, on a larger scale and with more ambitious goals owing to the subsidies received. However, the way they collaborate in their innovation process is not affected at all by the subsidies. Averages also hide some extreme responses such as the location of R&D and production facilities, which was a clear reference made by larger organizations with foreign parents. However, the SMEs with and without permanent R&D outnumber these larger firms. Therefore, these responses rank relatively low on the average scale. It is also clear that in this category of companies, the R&D projects do not lead to strategic changes in the companies. They have to be seen as a result of a new strategy, not a new cause.

The respondents suggest that the projects which received R&D support have contributed to a 19% increase of sales. Almost half of the projects have resulted in products that are commercialised today. An interesting result is that in 50% of the cases the IWT project has resulted in a new patent, but in only 10% of the cases, the project had a result on the patent strategy (see Tables 5.6 and 5.7). This means that companies which have a tradition to patent will continue to do so. However, those who have not are not likely to start patenting because of the R&D subsidy.

A final remarkable result is the fact that the R&D subsidies are considered to have a positive impact on the company image. Admittedly, this response is primarily found among the group of R&D-intensive SMEs.

Table 5.6. **Behavioural impact**

Behaviour: progress, conduct and strategy	Scale	Average (median)	Percentage responding "yes"
IWT grants were mainly in areas core to future business at time grants were received	0/1		50%
Type of origin of the funded project (3)	0-1-2-3		
Degree of market uncertainty (3)	0-1-2-3-4	2.3 (3)	
Degree of technological uncertainty (3)	0-1-2-3	2 (2)	
The effect of contact with the IWT during various phases of the project	0-1-2-3	1.45 (2)	
The influence of IWT or other public advisors on your partnership (3)	0-1-2-3-4	0.67 (0)	
Did the IWT support have an effect on patent strategy?	0/1		10%
<i>By receiving the IWT grant the project has been undertaken...</i>			
Slower/faster	Likert	3.8 (4)	
With fewer/more collaborators	Likert	3.5 (3)	
Smaller/larger scale	Likert	3.9 (4)	
Less/more ambitious goals	Likert	3.8 (4)	
<i>Impact on innovation strategy</i>			
Higher risk/return	Likert	3.4 (4)	
Parallel research paths	Likert	3.75 (4)	
Prolonged research that eventually turned out to be unsuccessful	Likert	3.5 (4)	
Research beyond short-term business needs	Likert	3.6 (4)	
Formalised innovation process	Likert	3.3 (4)	
Location R&D facilities	Likert	2.0 (2)	
Location production facilities	Likert	2.5 (2.5)	
Innovation management capabilities	Likert	3.2 (3)	
Support for the project within the company	Likert	3.3 (4)	
New enabling technology	Likert	3.6 (4)	
<i>The impact on collaboration</i>			
Prolonged collaboration with same partners	Likert	2.9 (3)	
Improvement of ability to network with other firms	Likert	3.7 (4)	
Improvement of ability to network with universities and public laboratories	Likert	3.4 (4)	
The project that received IWT support led to a change in business strategy	Likert	2.8 (2.5)	2.5

1. Whether or not an effect can be classified as an additional depends on the interpretation of the term additionality and on the availability of information for the non-IWT grant case.

2. If more than one product category is indicated, the average difference is taken. In case the product category did not exist at the moment that the grants were provided, only the actual percentage share at the time of interview is included, which equals treating the new product category as having a 0% share at the time of the subsidies.

3. Options to be weighted or scaled according to importance for additionality.

na: not available, either because of non-response, or response not relevant. For firms interviewed with earlier versions of the questionnaire it often indicates that the question was not posed.

Table 5.7. Results on output

Output: results	Scale	Average (median)	Percentage responding "yes"
Change in the % shares in total sales of product categories closely related to the IWT grants (2)	0 - 100	+19% (+0%)	
Project resulted in improved product that is currently commercialised	0/1		46%
% share in sales of this product	0 - 100	27% (10%)	
Likelihood that a new product will be commercialised in two years' time (3)	0-1-2-3-4	2.1 (3)	
Did the funded project result in an improvement of your production process?	0/1		50%
Spillovers of the funded projects to other departments of the company	0/1/2	1.2 (1)	
Spillovers of the funded project to other companies within the group	0/1/2	1.5 (2)	
Did the IWT-funded project result in a new patent?	0/1		50%
<i>What was the impact of the new products and processes that have been developed with the help of the IWT grants on your company's...</i>			
Product/service supply	Likert	4.7 (5)	
Market share	Likert	3.6 (4)	
Product/service quality	Likert	3.9 (4)	
Production process	Likert	3.6 (4)	
Profitability	Likert	3.9 (4)	
Competitiveness	Likert	4.3 (4)	
Enterprise image	Likert	4.2 (4)	
Future innovation potential	Likert	4.1 (4)	
The project that received IWT support allowed to improve research equipment	Likert	3.3 (3)	
The project that received IWT support eventually changed our manufacturing processes	Likert	3.5 (4)	

Conclusions

Conclusions related to the methodology

As stipulated in the introduction, the goal of this project was to develop a common methodology (research design) and instrument (questionnaire) to be used for future impact studies on the effectiveness of financial (and other) support for R&D in Flanders. The starting idea was that there exist four different categories of IWT clients that correspond to specific R&D grant regulations, firm size and frequency of R&D. After going through a process of developing, testing and evaluating the questionnaire with respect to measuring and identifying behavioural additionality, it was feasible to construct one common questionnaire at the project level for each of the groups. Only for the large R&D-intensive firms was an in-take interview also needed at the firm level in order to identify the appropriate project level and to collect information on the company's R&D and innovation process in which the various projects are nested.

Based upon these exploratory findings, the hypothesis is that different groups of firms find different types of impact and additionality important. Hence, the questionnaire instrument developed is a common one, but, the set of hypotheses that resulted from the exploratory part clearly suggest a difference between the groups suggested a priori.

Consequently, for three of the four groups (*i.e.* the SMEs and the large companies without permanent R&D), a similar research design was suggested. This research design involved 1) a discussion of the projects with the responsible domain representatives at the IWT, and 2) a telephone (or person-to-person) interview with the responsible person at the company. We are not in favour using the questionnaire in postal surveys as the content is quite complex and the questionnaire is rather long.

For the large companies with permanent R&D activities, which are also regular clients at the IWT, an additional data gathering step was introduced: the in-take interview. The data collection process is as follows: the first step is a screening of the projects for which the companies have received R&D grants with the administrators responsible at the IWT. However, in the next step, it would be better to have an in-take interview with the R&D manager of the company or equivalent. This interview should reveal the R&D or innovation process at the company's site. The main goal of the in-take interview is to get an idea about the innovation process and behaviour, and specifically to gain a better understanding about when project grants were asked for and whether these demands are made before or after the go/no-go decision.

Suggestions for a full-scale approach

Although the project departed from the idea that the target population was too diverse to be approached with one questionnaire, one core questionnaire with some customised modules is a good solution. Only for the group of large R&D-intensive companies is the questionnaire significantly different.

It is also important that the advisors or domain co-ordinators at the funding agency be actively involved in the evaluation exercise. Their background concerning the specific projects subsidised or the companies in general is invaluable for the researchers in the field.

Based upon this experience, postal surveys do not appear to be an effective route for evaluating additionality effects. Interviewers can process information in a more homogeneous way than interviewees can in such a complex domain. The data collection exercise is targeted towards the different sub-segments in the population. In the group of R&D-intensive large firms, the contact person should be visited at least once, namely during the in-take interview. This in-take interview is necessary to understand the innovation process in place at the company's site. The second stage of data collection can be done by phone, although a personal visit is preferable. For the three other groups, the data can be collected making use of telephone interviews.

The research design included suggests a particular selection of the companies. Because first experiences confirm that the four groups of companies are quite different in terms of additionality results, it is important to keep the distinction and select the more extreme cases (as suggested in Figure 5.2). These cases belong to the top or the bottom quartiles in terms of R&D size. The result of this selection is a manageable sample frame. There are fewer than 80 R&D-intensive large companies to be included in such an examination in Flanders. This means that the population of these companies can be covered instead of taking samples. For the three other subgroups, sampling is still necessary. The high-tech start-ups or R&D-intensive SMEs are estimated to be a group of about 450 firms. The non-R&D-intensive SMEs are even a larger group and the non-R&D-intensive large firms also represent more than 100 companies.

Because the population of R&D-intensive large companies is almost fully covered by the IWT, no matched pairs can be made between companies that have and those that have not received subsidies. For the other three groups such a design is possible and desirable but not absolutely necessary. Matched pairs increase the analytical possibilities. It is also possible to compose a control group of applicants that were turned down. The question of attribution of the observed effects on subsidy or other factors and the distinction of the additional effect as such from the total effect is still open for further research. A possible approach is to compare behaviour with those firms that have been denied support.

The questionnaire developed allows differentiating between the different forms of additionality along the theoretical lines stipulated by Georghiou. The questionnaire has been developed with greater detail, departing from the checklist presented by Georghiou (2003). The analytical use of the typology and the additionality data can only be shown using a database that has a critical number of observations. On that level, appropriate metrics can be developed to quantify the survey results.

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Chapter 6

BEHAVIOURAL ADDITIONALITY OF PUBLIC R&D FUNDING IN FINLAND

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Abstract. This chapter reviews results of several research efforts that provide insight into how public R&D financing in Finland changes the behaviour of firms with regard to their R&D activity. The results indicate that public R&D funding has a positive impact on firms' behaviour as it makes them more competitive, more capable of conducting R&D, better endowed with human capital, and also expands their collaborative networks. Such effects not only benefit firms, but can also increase the well-being of Finnish citizens. One of the main drivers of these behavioural changes is the fact that funding from the National Technology Agency of Finland, Tekes, has been successful in altering the direction of firms' R&D activities. It has improved the R&D activities of small and medium-sized enterprises (SMEs), in particular, because most of their projects would be difficult to realise without public funding given their scale and technological challenges. As an evaluation tool, behavioural additionality is still in its early stages of development. There is still work to be done both methodologically and empirically to further develop the concept. The results reported in this chapter are essential steps in doing so.

Introduction

Growing recognition of the importance of R&D in economic performance has led policy makers to seek effective means of promoting innovation activity. According to Statistics Finland, over EUR 5 billion was spent on R&D in Finland in 2003, representing 3.5% of GDP. Business R&D expenditure totalled EUR 3.5 billion; that of universities and polytechnics accounted for EUR 1 billion; and the rest was performed by the public sector (government research organisations). A political goal of the European Union is to raise R&D expenditures to 3% of GDP throughout the EU area. Despite some ambiguities in the definitions of innovation and the policy measures that can be used to improve innovation performance, there is clear pressure to reform the provisions of European legislation that aim at promoting innovation.

Tekes, the National Technology Agency of Finland, is a key player in the Finnish innovation system. It offers financing to firms for industrial R&D and provides grants to public organisations for applied technical research in addition to providing R&D advice. Tekes has taken several steps to examine the interrelationships among public R&D funding, innovation policy, economic growth, productivity and firm behaviour. The purpose of these examinations is to offer fresh insight into the ways Tekes' operations can be improved to further advance its role in promoting economically successful innovations.

The challenge in such analyses is that existing research is fragmented among studies of firm-level, sectoral and national effects. Therefore, the aim of one sub-project called *econometric methods of estimating the impact of R&D funding* is to build up links or rules of thumb among those effects. It includes efforts to analyse the impact of R&D funding at the project, firm and sectoral levels, as well as at the national and global levels, and to find a common thread that connects these various impacts.

Tekes is one of several institutions in the Finnish innovation system that explicitly aims to steer firms' R&D behaviour in desirable directions (Box 6.1). As a result, the concept of *behavioural additionality* has become one of the evaluation tools used to help explain changes in the desired direction in a firm's R&D behaviour.¹ Because the survival of R&D-performing firms and additionality differences between R&D firms are one of the main interests of Tekes, this study reviews empirical evidence found in three recent evaluation studies of the additionality of Tekes R&D funding on Finnish firms: a macroeconomic analysis of the effect of Tekes funding on levels of business R&D funding (input additionality); an econometric model of the interaction between Tekes and firms in the process of applying for an R&D grant; and a recent survey of business managers about the effects of Tekes funding on their R&D practices. When these additionality topics are analysed more closely, the impact on the innovative behaviour and business know-how of R&D-performing firms in both the service and manufacturing sectors emerges as one of the main results of Tekes funding.

Box 6.1. Key institutions in the Finnish innovation system

Finnvera offers risk financing and other financial products such as export guarantees to SMEs in particular.

Finnish Industry Investment Ltd acts in the Finnish venture capital market.

Regional TE centres provide a complex range of services in order to activate SMEs.

Finpro encourages firms to seek international markets by offering international marketing services to innovation networking.

The *Foundation for Finnish Inventions* offers early-phase services related to innovation.

Other organisations connected to the Finnish innovation system, including Sitra (the Finnish National Fund for Research and Development), the Academy of Finland and Finnish universities (MTI, 2002).

1. Behavioural additionality is seen as a complement to more traditional approaches to evaluation of R&D programmes, which tend to focus on input additionality, which is described by Georghiou (2002) as examining “whether for every euro provided in subsidy or other assistance, the firm spends at least an additional euro on the target activity”; or output additionality, which includes “the proportion of outputs which would not have been achieved without public support” (Georghiou, 2002). It is difficult to separate those outputs that result from public R&D support from those that would have resulted from the firm's own efforts.

Impact of public R&D funding on private R&D behaviour

Tekes has been active in clarifying how public R&D financing might affect firms' own R&D efforts. For example, Tekes took part in a project by Ali-Yrkkö (2004) in order to examine the impact of public R&D financing on the R&D funding of Finnish companies. This project was based on an econometric analysis of whether public and private R&D financing are substitutes or complements. The study targeted companies operating in the metal, engineering and electronics industries and examined how financial constraints might affect R&D funding. It pays particular attention to capital market imperfections by examining what kind of effect financial constraints have on the relationship between public and privately funded R&D. Because R&D investments are uncertain and intangible in nature, firms tend to prefer internal financing to more restrictive external finance. In such circumstances, firms might be more interested in applying for public R&D financing rather than risking the interruption of their R&D activity to acquire external financing. The estimation results suggest that public R&D financing does not crowd out private R&D financing; instead, receiving a positive decision to obtain public R&D funds *increases* privately financed R&D. Furthermore, the results suggest that this additionality effect is greater in large firms than in SMEs.

Selectivity in public R&D funding and strategic firm behaviour

The objective of another research project by Takalo, Tanayama and Toivanen (2004), financed by Tekes, concerned the allocation of publicly funded R&D to privately conducted R&D projects. The main research questions included: 1) how does the agency's selection mechanism allocate grants to applicants? and 2) how is the funding policy reflected in the characteristics of applicants for funding? To achieve these objectives, descriptive, theoretical, and econometric research was carried out.

The study concentrated on two separate groups of firms: those who applied for public funding, and those who financed their R&D in some other way. The original financial data included 539 applicants for funding and 11 990 non-applicants. The ETLA survey picked up 66 applicants and 741 non-applicants.² In total, 1 036 firms applied for business R&D funding from Tekes in 2001, and 722 received a grant. Those firms that received Tekes funding were primarily manufacturing SMEs, for whom the acceptance rate was higher than for service firms. The technological novelty of the proposed project and the novelty of the application to be developed had a strong, positive effect on the acceptance rate. This rate increased with technological challenge of the proposed project and the degree of internationalisation of the firm. The inclusion of international collaboration in the proposed project further increased the acceptance rate.

Econometric methods were applied to a model of the grant application process that included four steps (Takalo *et al.*, 2004). First, firms generate ideas for research projects that require investments in R&D. Second, firms have to decide whether or not to apply for public funding. Public funding can lower the marginal cost of R&D because the funding agency (in this case Tekes) promises to pay some fraction of the R&D costs. Applying for funding entails costs, however, and a firm has to consider the benefits and costs of applying, using the information they have about how the agency makes decisions. This information is not perfect, of course, so sometimes firms make wrong decisions.

2. The Research Institute of the Finnish Economy (ETLA) database.

Third, the agency screens applications it receives and decides, on an application-by-application basis, the level of funding that will maximise the utility of agency. There are many reasons why the agency's utility differs from that of an applicant firm. For example, an agency that aims to maximise social benefits takes into account consumer surplus and spillovers to other firms in its decisions. Fourth, after receiving the funding decision, firms invest their own resources in R&D. An important feature of the model is that it assumes this investment takes place after the agency's funding decision. An implication of this approach is that applicants re-optimize their R&D investments: a firm that gets no public funding may invest a different amount than if it received funding.

To interpret the results, this analysis can be divided into three parts:

- First, an R&D investment equation that describes the size and activity in the application process seems to indicate that firm size (measured by sales) and sales per employee have a positive effect on marginal profitability of R&D. The number of previous applications made by a firm has no apparent effect on the marginal profitability of R&D.
- Second, an application cost equation clarifies how firms balance their application costs against anticipated benefits. The parameters indicate that firms with higher levels of sales per employee have higher application costs. This finding most likely reflects their higher opportunity costs of applying. Moreover, exporting firms are seen to have lower costs, and firms with a larger number of previous applications have lower application costs. In other words, those firms that have low application costs are more likely to have applied previously.
- Third, parameters of Tekes' decision rules show that firms with technologically more challenging projects (as determined by Tekes) receive funding for a higher share of their project cost (a one point increase in technical challenge, as measured by Tekes, leads to a 10 percentage point increase in subsidy), as do SMEs (some 8.5 percentage points) and firms in rural areas – even though Tekes has no policies that would give preference to the latter.

Impact of Tekes funding and behavioural additionality of Finnish firms

The interpretation of behavioural additionality resulting public R&D funding can be measured as two kinds of desired changes in firm behaviour. First, it can be interpreted as a desired change *during the project* (compared to the situation without funding), such as an increase in the scale of an R&D effort or in the degree of collaboration with other partners. Firms might still conduct a research project without public funding, but with reductions in scale or an extension of the schedule or different degrees and types of co-operation. Second, public funding could lead to desired changes *after the project*. A firm might manage its R&D projects or co-operate with partners in different ways after participating in the government-funded project (Georghiou *et al.*, 2002).

A Tekes project to investigate this phenomenon was carried out by Pekkanen *et al.* (2004). The study aimed to evaluate business manager's attitudes about the additional effects of Tekes R&D funding. A random sample of 1 000 manufacturing and services firms (including 200 Tekes customers) was drawn from a database of more than 15 600 firms managed by Statistics Finland.³ A questionnaire was sent to 645 managers of these firms (including 170 Tekes customers) to inquire about their perceptions of the impact of public R&D funding. Managers were asked to rank – on a scale from “agree completely” to “disagree completely” – their attitudes about impacts of Tekes funding on: 1) their firm's financial development and profitability; 2) levels of collaboration, credibility, publicity and investor relations; and 3) their firms' R&D practices and strategies. Responses were received from 193 firms, of which about 80 were Tekes customers. Most of the firms were SMEs and non-clients with fewer than five employees, such as small-scale information technology and engineering offices. Firms with more than 100 employees comprised about one-fifth of the sample.

The results show a number of differences between Tekes clients and non-clients (Figure 6.1). R&D-performing firms that were Tekes clients were more likely to engage in product innovation (creating new products or improving existing ones) than non-clients (73% of Tekes clients vs. 50% of non-clients). Non-clients, however, were more likely to engage in process innovation (develop new processes and improving existing ones) (42% of non-clients vs. 22% of clients). These results might reflect the fact that non-clients worked to improve processes that were not yet commercialised or that they were sensitive in protecting their comparative advantage and were disinclined to co-operate in their innovation process. However, most non-clients might be appropriate Tekes clients because they engage in high-technology R&D and/or development of nascent technology bases.

Change in firms' financial situation

Both firms and government funding agencies recognise that one aim of public R&D funding is to improve the competitive position and profitability of a firm as measured by key financial indicators. Government funding agencies also have the objective of improving the well-being of its citizens. Spillover effects, though, cannot only take place between firms, but within a single firm when the benefits of one project can be utilised in a firm's other projects. According to the survey results, 40% of business managers agree that Tekes funding has improved their profitability, and more than 60% believe that Tekes funding has helped boost their turnover (Figure 6.2). Considerable evidence also indicates that public funding had benefits for projects beyond the firm's target project. More than 50% of the managers agreed that innovations spill over into other parts of the firm by improving the quality of those projects.

3. Firms came from the manufacturing industries associated with ISIC classes 15-37 and from the knowledge-intensive service industries associated with ISIC 72-74.

Figure 6.1. Investment behaviour in R&D firms

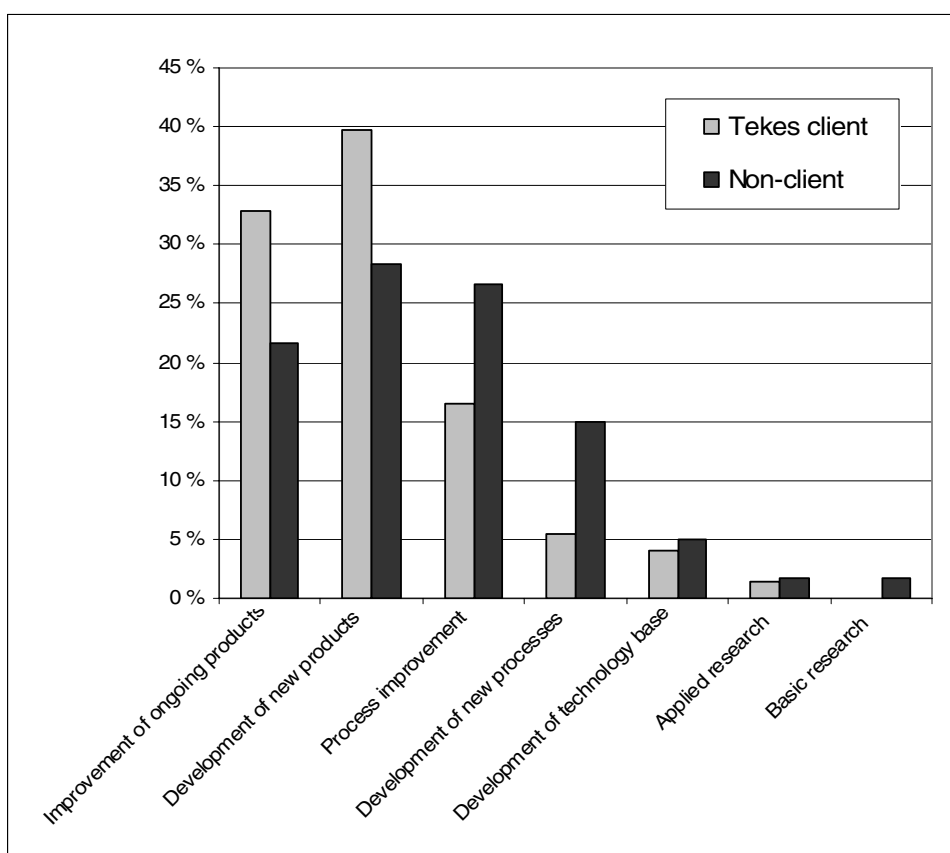
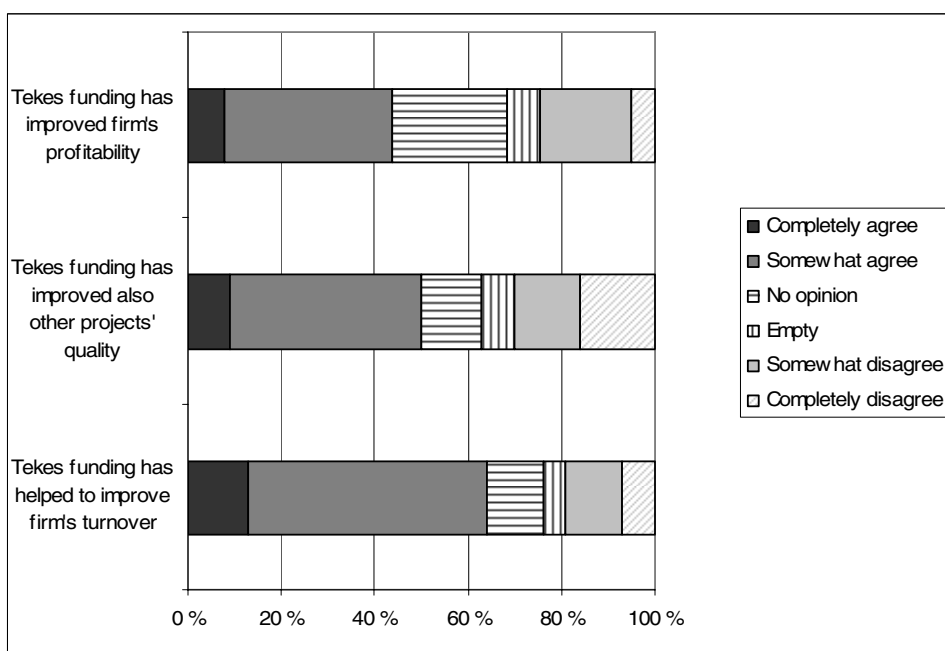


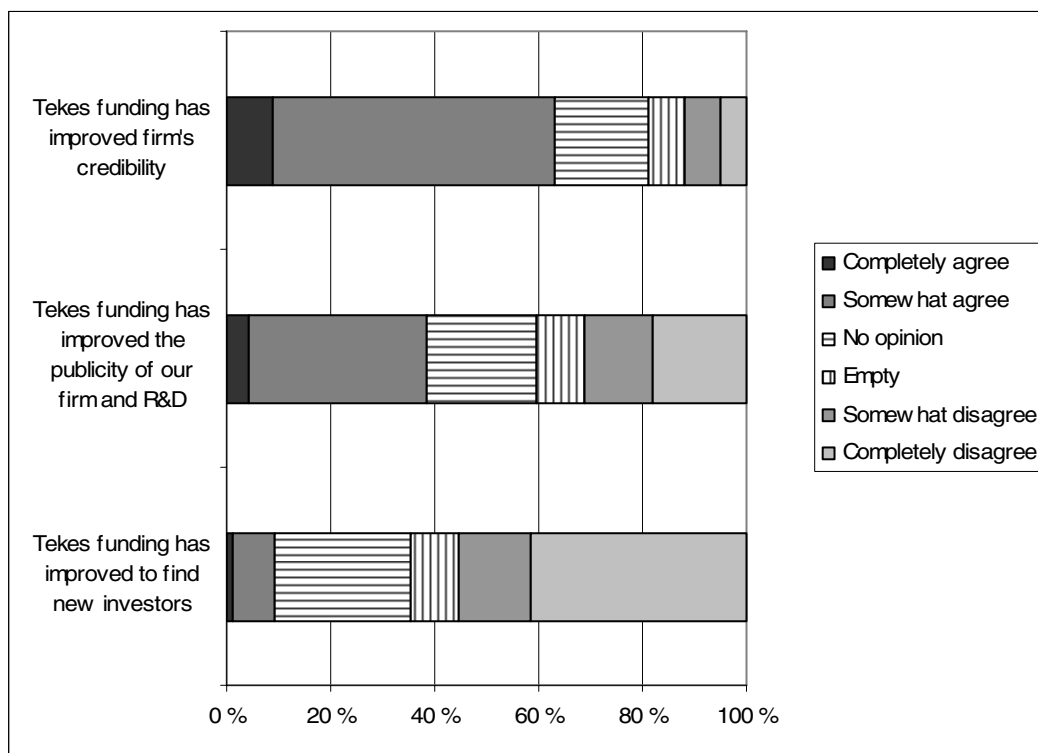
Figure 6.2. Impact of Tekes funding on firms' financial development



Change in external relations

An important fact in spillover and innovation literature is that a critical mass of actors is necessary to be successful (Baldwin, 1989). Successful spillovers can be found in regions in which similar types of firms work in clusters and spread their knowledge by co-operating in addressing similar problems. Skill spillovers are supported by the fact that skilled employees have few barriers to using each other's information. Such clusters can be formed among the R&D firms, R&D centres and universities, etc. Such a view also implies that a key factor for increasing skill accumulation in the R&D firms is close links with the high-technology international firms and advanced technology programmes. Public R&D funding can be one of the main links stimulating this clustering by increasing firms' publicity of technology and helping them find new investors. The survey clearly shows that Tekes funding has helped to improve firms' credibility (Figure 6.3). More than 60% of respondents estimate that Tekes funding improved their credibility, and only 12% disagree. Almost 40% believe that the firm itself and the technology investigated gained greater publicity as a result of their participation in the Tekes programme. On the other hand, only weak evidence exists that Tekes funding improved investor relations, as only 10% of managers reported that they had found additional investors. However, it might also be noted that most of the firms were not seeking additional financing because their financial situation was strong enough or they had already found sufficient external sources of financing (*e.g.* venture capital).

Figure 6.3. Impact of Tekes funding on external relations



Change in firms' R&D practices and strategies

Enhancement of the R&D practises and managerial strategies are among the goals of Tekes R&D programmes and are closely related to the concept of behavioural additionality. The survey illustrates that Tekes funding has affected firms' long-term business strategies to varying degrees. Around 44% of respondents agree either strongly or somewhat with the statement that Tekes funding changed their business strategies, although 35% disagreed with this statement (Figure 6.4). More clearly, Tekes funding changed firms' R&D strategy in respect to time horizons of their R&D and risks associated with R&D projects. More than 70% of respondents agreed that Tekes funding enabled them to realise riskier and more profitable research, and over 60% indicated that they pursued R&D that is not connected to the short-term needs of business operations. These results indicate that Tekes funding has been successful in influencing firms' R&D activities. It has been especially helpful in the case of SMEs, which would have been unable to realise more demanding R&D projects considering the scale and degree of technical challenge.

Firms also report that Tekes funding improved their ability to enhance their human capital. About 80% of firms reported that Tekes funding had increased the know-how of their personnel. This enhancement of cognitive capacity can lead to long-term changes in behaviour (Bach and Matt, 2002). This is especially important in the current global environment in which competition for skilled employees is increasing and R&D-performing firms compete more aggressively to hire high-skilled employees from universities and from abroad (including from low-wage countries). Availability of human capital can also make regions more attractive in the eyes of increasingly mobile R&D firms (Machin and Reenen, 1998), meaning that improvements in human capital can have widespread economic effects.

Tekes funding also appears to assist companies in their efforts to form and internationalise co-operative networks. It helps R&D-performing firms find external partners that can offer technological capabilities that complement their internal capabilities and match their needs (Hyvärinen, 2004). More than half of all respondents indicated that Tekes funding help them strengthen their networks of co-operation. Increasingly, co-operation has an international dimension, as do production networks and markets. Almost half of all firms (44%) thought that Tekes funding supported their internationalisation process, but almost same percentage (39%) disagreed. When only international firms are considered, a majority of managers (60%) felt that internationalisation was more progressive with Tekes funding. Nevertheless, Tekes funding does not seem to have exerted much influence on the location of R&D or production.

Types of projects supported

Discovering which types of projects firms propose for Tekes funding is important in evaluating the impact of the agency on the Finnish innovation system, as is determining whether R&D projects would have been realised in the absence of Tekes funding. According to the survey, approximately two-thirds of Tekes clients applied for funding for key projects, *i.e.* projects that are strategically important to the firm and technologically challenging. From the Tekes perspective, these key projects are those that most improve and expand networking capabilities, and which provide broad economic and social benefits. Almost half of the Tekes clients indicated that they had applied for funding for a project that would be too risky for them to carry out alone. This result clearly indicates additionality because these projects would not have been realised without Tekes funding.

Any resulting changes in R&D funding levels, outputs and behaviour would, by definition, be additional.

Figure 6.4. **Impact of Tekes on firm behaviour**

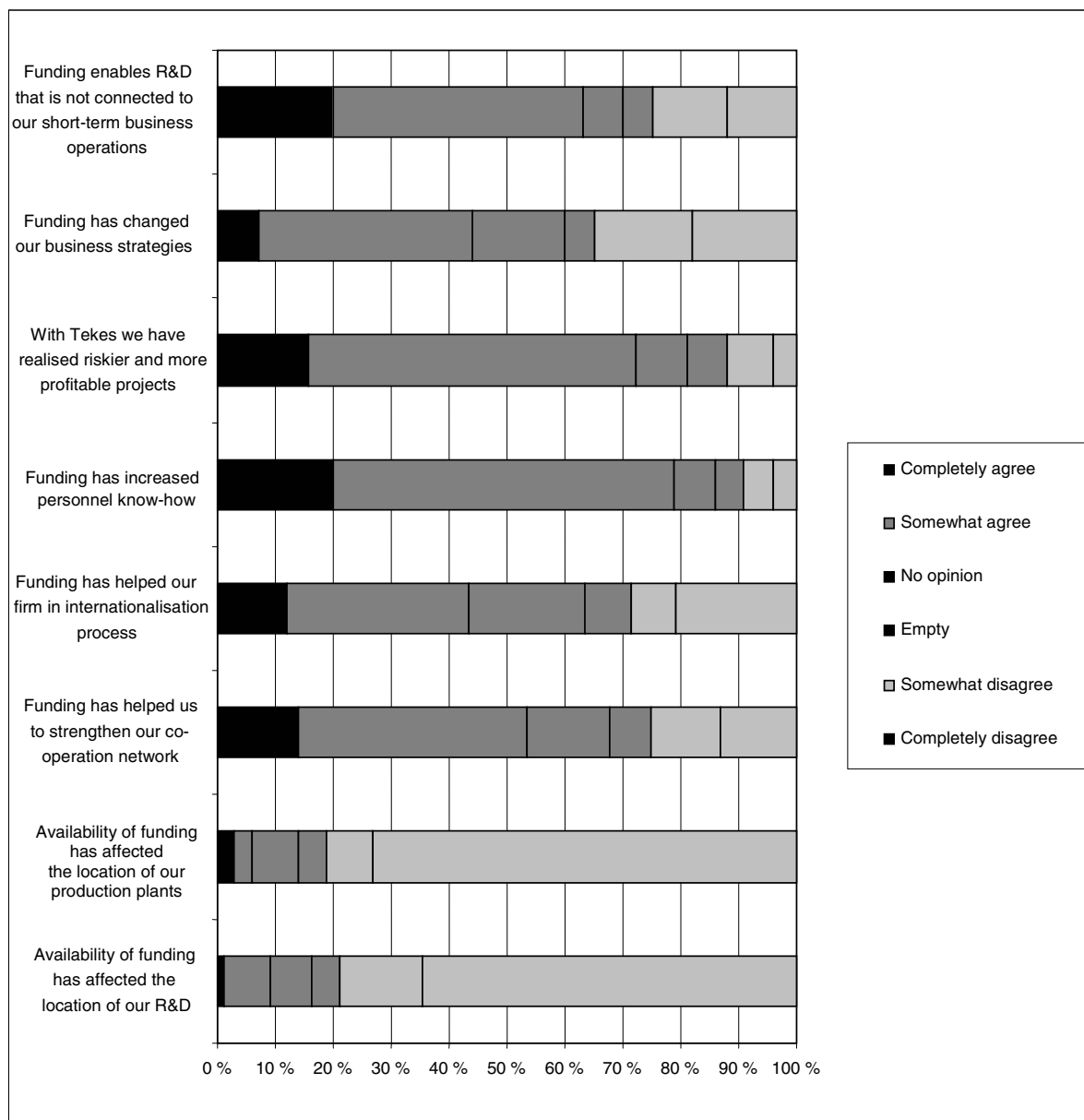
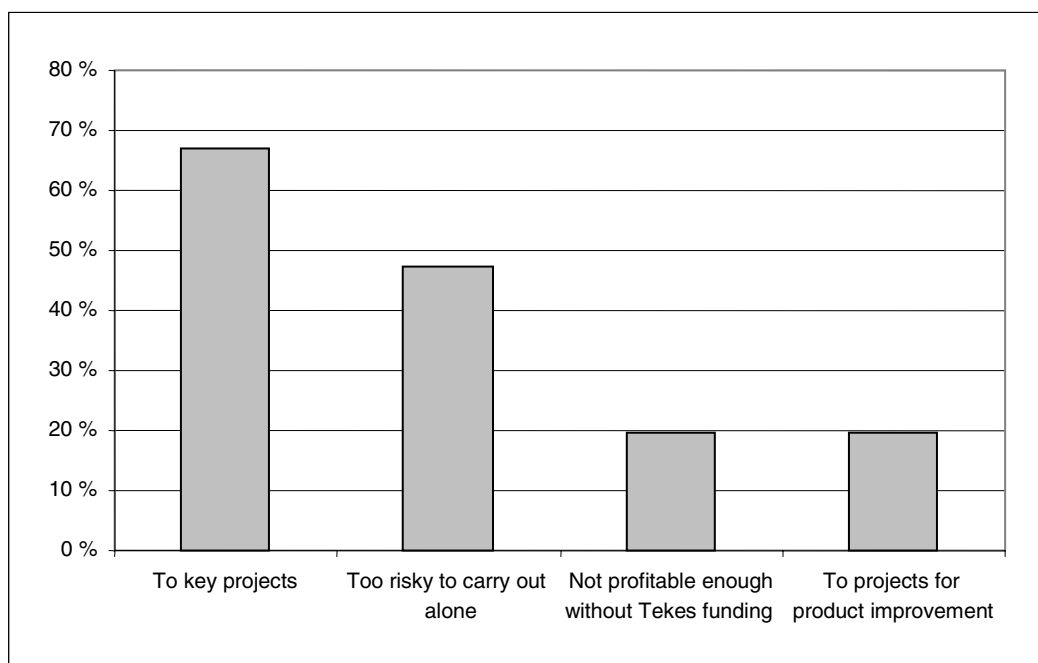


Figure 6.5. Focus of Tekes funding



It is more complicated to estimate costs and benefits of projects that firms thought would not be profitable without Tekes funding (20% of respondents). Public funding aims to address market failures, *i.e.* to support projects that would not be immediately profitable. However, some projects that might not generate immediate profits for an individual firm can develop new knowledge or radical innovations that might offer significant benefits to other firms and to society in the future. There can be an important government role in such areas, which accounted for about 20% of the responses to the survey.

Changes induced by Tekes' application process

Behavioural changes can also be induced by the process of applying for a government R&D grant. For example, Tekes imposes several criteria on proposals that relate to their technological content, degree of networking and levels of domestic content. In the survey, managers were asked to indicate how they take these considerations into account in developing their proposals. They were asked whether: 1) they did not make any specific changes to their proposal because they already planned to fulfil the requirements; 2) they increased subcontracting (networking) in order to acquire funding; 3) they increased co-operation with research institutes (networking) in order to acquire funding; 4) they increased the domestic content of the project in order to acquire funding. The majority of managers (55%) indicated that they did not specifically take these Tekes requirements into account and would have fulfilled them anyway. Of those who did modify their plans in order to meet Tekes requirements, the most common practice was to enhance co-operation with research institutes (done by half of firms that modified their plans, see Figure 6.6). More than one-third of managers increased subcontracting with other firms. Only a small fraction (5%) transferred activities to Finland from other countries. Other activities that might be helpful in acquiring Tekes funding are discussing and preparing projects with

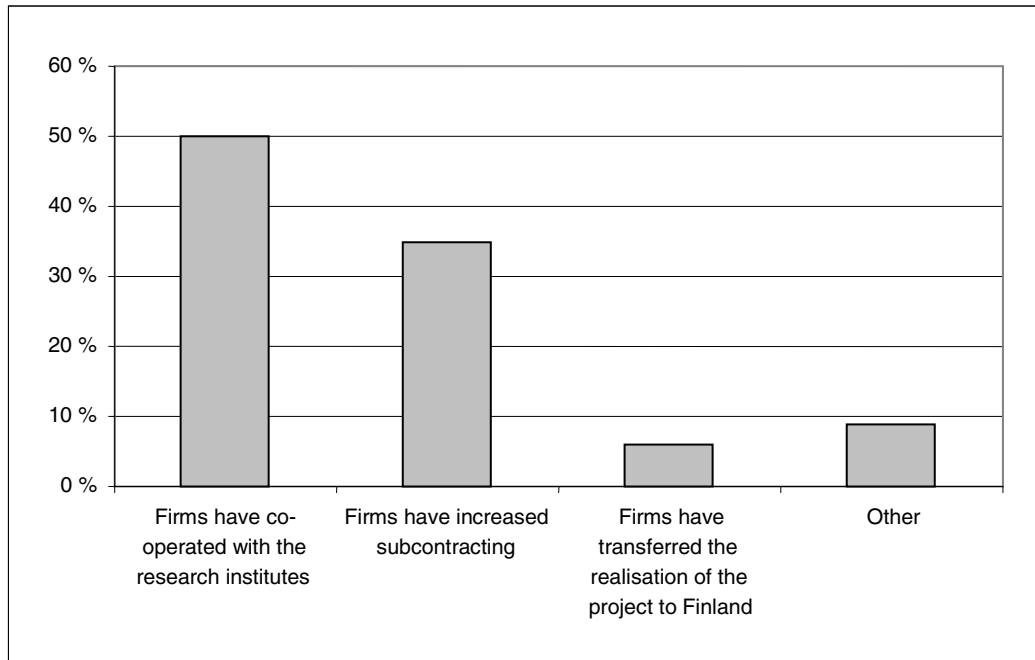
Tekes officials before submitting applications and exploiting external experts in preparing applications.

Another way to examine the effect of Tekes funding on business R&D is to ask managers how the termination of public funding might change their R&D projects on the long run. Responses vary considerably. About 10% of clients responded that they would continue without modification if funding were terminated (no additionality). Almost half of the respondents indicated that they might downsize their projects, which suggests strong input additionality (see Table 6.1). Some of the firms are quite heavily dependent on Tekes funding. Those firms, comprising about one-fifth of clients who answered, work in new R&D areas or have R&D activities at a critical stage; they report that termination of Tekes funding would shut down their entire R&D activities, which can be interpreted as a sign of strong behavioural additionality.

Table 6.1. Termination of funding and additionality

Impact of termination of Tekes funding	Additionality of funding	Share of firms
R&D activities continue unchanged	No additionality	11 %
Same projects would be realised with fewer resources	Strong input additionality	46 %
Present R&D-activity should be shut down	Strong behavioural additionality	20 %
No response	-	23 %

Figure 6.6. Foresight of Tekes requirements



Conclusions

As this chapter illustrates, additionality is a challenging concept to apply as an evaluation tool for public R&D funding. The results reported in this study are more preliminary than comprehensive and are based on limited samples of firms drawn from surveys and econometric analyses; however, they clearly indicate that public R&D funding has improved firms' R&D practices and strategies and helped them become more competitive. It has also improved the capabilities of their human capital and the quality of their R&D, and facilitated expansion of their co-operation networks. These types of changes bring benefits not just to the firm but the economy as a whole and the well-being of the country's citizens. Both econometric results and survey responses imply that firms have increased their own R&D financing after acquiring public R&D funding. One of the main findings of the selection study is that Tekes prefers those projects that are most technologically challenging, and firms with technologically more challenging projects (as measured by Tekes) receive a higher funding percentage. Still, using output and behavioural additionality as evaluation tools is a learning process, and these results are essential steps in elaborating the broad framework of this approach.

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Chapter 7

BEHAVIOURAL ADDITIONALITY OF PUBLIC R&D FUNDING IN GERMANY

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Abstract. Subsidising research networks has become a popular instrument in technology policies, driven mainly by expected positive spillovers. In particular, the stimulation of R&D co-operations between science and industry seems most promising which, in the context of policy evaluation, is addressed in this study's focus on R&D collaborations and public funding. This study analyses if changes in a company's behaviour were caused by public R&D funding of collaborative R&D projects. The empirical analysis is based on German CIS data and a supplement telephone survey. Using a neighbour matching approach it is found that R&D funding is, in fact, a particularly valuable tool for the linking of science into industry R&D partnerships. However, we also show in a bivariate probit analysis that newly initiated R&D co-operations with science, compared to already existing co-operations, are less likely to be continued after funding has ended.

Introduction

Public funding of research and development (R&D) activities is an integral function of innovation policies implemented by the governments of most OECD countries. Its primary objective is to increase the innovative potential as well as the competitiveness of the respective economy. In the face of shrinking government budgets and intensified international competition in the field of technology, increasing the efficiency of innovation policies has become crucial (OECD, 2004a). Hence, there is growing demand for rigorous evaluation of R&D policies to form the basis of national learning processes and sound decision-making by policy makers and participants. Evaluations of R&D incentive schemes are of particular importance in judging the impact and effects related to such governmental interventions. The impetus behind the popularity of evaluation approaches is linked to growing expectations in achieving additional sustainable returns on public investments, defined by the term 'additionality'.

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Evaluations are broadly defined as systematic and objective assessments of ongoing or completed projects, programmes or policies with respect to design, implementation and results. Their primary concern is to shed light on the key criteria of efficiency, effectiveness, impact and sustainability, as policy makers and, in the end, taxpayers inquire about the additional effects which may result from a policy measure (OECD, 2001). Any concept of measuring additionality has to deal with the question of how policies have affected the current situation or performance of participating agents or sometimes even of the entire economy. However, as regards a likely causal relationship to public funding, recent empirical evaluations often come to focus on additional private firms' inputs, *e.g.* supplementary R&D investments, or companies' additional outputs, *e.g.* increasing patent applications, (*cf.* David *et al.*, 2000; Czarnitzki *et al.*, 2004). Besides these short-term observations, firms might also change fairly long-term behaviour. Perhaps, public R&D funding may, thus, even modify the firms' strategic or organisational outset, such as in terms of changes in collaboration preferences.

This study focuses on aspects of 'behavioural additionality' in the context of national innovation funding of private businesses in Germany. We ask whether Germany's R&D policy, *i.e.* its most important tool, public R&D project funding, is adequate for influencing firms' collaborative behaviour. In particular, we investigate different types of collaborative research due to public R&D funding. The hypothesis is that public R&D funding stimulates firms to participate in new kinds of R&D co-operation. Moreover, we examine if within a publicly funded R&D project newly initiated collaborations, *i.e.* in the case where a company collaborated with the partner for the first time, are more likely to last compared to already existing co-operations, even if public funding has ended. On the one hand, companies might overcome prior reservations to co-operating in their strategic field of R&D by discovering valuable assets in joint R&D and therefore maintain in collaborating. On the other hand, newly initiated co-operations might bear a higher risk of failure due to differing expectations regarding the project outcome or of the formerly unknown project partner.

The structure of the remainder of this chapter is as follows. First, we give a brief overview of economic theory and the rationale for public funding of business R&D. In the second section we analyse the significant change witnessed in the German federal government's funding policy, which preferred single R&D grants and large companies in the 1980s and moved to collaborative R&D grants and small and medium-sized enterprises (SMEs) in the 1990s. In the empirical section we describe the data and the econometrics applied, followed by a presentation of the results.

Rationales for collaborative R&D funding

Theoretical issues on the characteristics of R&D

Starting with Arrow's (1962) work, economists have realised that investment in R&D differs substantially from other types of investment, *e.g.* in physical assets. R&D consists of knowledge, which has characteristics typical of a public good (Coase, 1974). Unlike investment in physical assets, returns on the creation of knowledge cannot be fully appropriated by the inventor. In the business sector such knowledge leaks out of the firm, *e.g.* by employees leaving the company; also, competitors benefit from the inventor and original investor's efforts. Due to these externalities, economists recognise the two sides of R&D as a rather general problem: leaking knowledge increases social returns but reduces private returns and prevents any R&D activity in the long run. In the case that R&D could possibly generate high social returns without covering the private cost, market

failure occurs and the level of R&D activities in the economy in question is thus below the socially desirable level (Levin *et al.*, 1987; Mathews, 1996).

Besides these theoretical arguments there is practical evidence that R&D is more difficult to finance than other types of investment. Due to its intangible character, it does not offer any collateral in credit negotiations. Furthermore, the inherent risk of failure associated with each project leads to the fact that potential investors are reluctant to finance such investments, since they have less information about the expected returns than the firm. To overcome such market failures, governments use a variety of policies to enhance technological progress (Fahrenkrog *et al.*, 2002).

In OECD countries four main policy instruments are used to overcome market failure: establishment of public research infrastructure, government funding of R&D performed by businesses, fiscal incentives, and property rights. Public research is often carried out by public laboratories or universities to satisfy public needs and to offer knowledge to industry. Public R&D funding is provided by governments in the form of procurement, subsidies or grants. Ideally speaking, governments invest in R&D projects to achieve certain objectives (*e.g.* public health or national security) which seem to have high social returns. Further policy instruments are tax incentives: companies are allowed to deduct current R&D expenditures from their tax burdens. Moreover, governments compensate for market failure by using property rights such as copyright law or patent law to protect knowledge which has been exclusively paid for and generated by a firm. Today, many countries have implemented a mix of these policy tools to foster domestic innovation performance (Capron and van Pottelsberghe, 1997).

Patterns of R&D collaborations

The question of how and why firms engage in collaborations, partnerships, alliances, joint ventures and networks emerged in economic literature during the 1980s. Different theories and empirical studies have analysed the mechanisms and benefits of research consortia (Katz, 1986; d'Aspremont and Jacquemin, 1988; Freeman, 1991; Kamien *et al.*, 1992; Katsoulacos and Ulph, 1998; Robertson and Gatignon, 1998; Kamien and Zang, 2000; Cassiman and Veugelers, 2002). The evidence of significant spillovers of private investments in the field of R&D and innovation is shown by a host of empirical analyses (OECD, 2004b; Klette *et al.*, 2000; Jones, 1998).

Hagedoorn *et al.* (2000) give an overview of strategic research partnerships and identify three broad categories explaining why firms enter into research partnerships: *a)* transaction cost theory, *b)* strategic management theory and *c)* industrial organisation theory. In transaction cost theory, R&D co-operations are explained as a hybrid form of organisation between the market and the hierarchy to facilitate an activity specifically related to the production and dissemination of technological knowledge. Due to lacking appropriability of R&D, positive external effects are generated. In order to internalise such effects, companies prefer to engage in research collaborations with possible third party users of their research results. In strategic management theory, research partnerships are explained by competitive reasoning (jointly defending market positions against competitors), by strategic networks (economies of scale and scope), by a resource based view of the firm (to exploit unique capabilities), by dynamic capabilities (to combine competencies) and by strategic options on new technologies (to determine resources for superior future performance). In the theory of industrial organisation, research collaborations are explained by the existence of market failures due to the perceived public good nature of knowledge. The majority of theoretical studies deal with imperfect appropriable

R&D and an increase of market power. Bayona *et al.* (2001) review similar reasons to explain co-operation: 1) the reduction and sharing of uncertainty and costs, 2) motivations related to market access and the search for opportunities, 3) size and R&D capacity as characteristics of the firms.¹

Recent empirical studies finding that the number of partnerships has largely increased affirm that contractual forms of R&D, such as joint R&D have, indeed, become a very important mode of inter-firm and science-firm collaboration (Sakakibara, 1997; Hagedoorn and Narula, 1996). Sakakibara (2001) analysed Japanese government-sponsored R&D consortia over 13 years and found evidence that the diversity of a consortium is associated with greater R&D expenditure by the participating firms. Overall, the results provide support for spillover effects. The magnitude of the effect of participation in an R&D consortium on firm R&D expenditures is found to be 9%, on average. Branstetter and Sakakibara (2002) examine the impact of government-sponsored research consortia on the research productivity in Japan by measuring their patenting activities over time. They find evidence that participants of research consortia tend to increase their patenting after entering a consortium, which is interpreted as evidence for spillovers. The marginal increase of participants' patenting in targeted technologies, relatively to the control firms, is large and statistically significant.

Public funding and R&D collaborations

In Germany, direct subsidies for R&D bound to co-operations and networks became a popular instrument in technology policies at the end of the 1980s. In theory, externalities such as pecuniary spillovers, knowledge spillovers and network spillovers are supposed to lead to market failure by adversely affecting the incentives of individual firms to invest in R&D (Adams and Jaffe, 1996; Caloghirou *et al.*, 2003). Consequently, the German government decided to reconfigure the incentive structure and allow spillovers by phasing out such former policies which relied on project-specific funding of single awardees and advance a collaboration-oriented policy scheme. This has been addressed, in particular, at SMEs and scientific research and intervention. The main objectives associated with this policy change are to increase public funding efficiency and to strengthen national competitiveness.

In general and in line with theory, the German federal government justifies its public R&D funding with the existence of external effects, *i.e.* that third parties can use research results and thus gain an economic advantage without paying the technology developer a fee. "In such cases the incentives may be too weak for innovative companies to develop private R&D activities in these areas to the desirable extent if economic profitability considerations were included" (BMBF, 1993). The further argumentation in funding collaborative R&D projects runs along the line of spillovers and the desired know-how transfer: "collaborative R&D intends to involve as much companies and scientific organisations as possible within a publicly funded project, to bundle individual resources, to stimulate the technology transfer between industry and science, and to achieve synergies while funding should get less selective but more diffusive" (BMBF, 1988; BTDRs, 2005). The aim is to achieve a widespread efficiency of public R&D funds by stimulating "multidisciplinary R&D collaborations *e.g.* between social, natural and engineering

1. Further theoretical arguments concerning questions related to research partnerships can be found, *e.g.* in Vonortas (1997) or de la Mothe and Link (2002).

scientists” (BMBF, 2004) and “heterogenous R&D collaborations, *e.g.* between industry and science” (BTDRs, 2005).

From policy researchers’ point of view, governments prefer to subsidise collaborations because of further implicit advantages: A collaborative funding approach addresses more and different players compared to single project funding approaches. Today, public R&D funding addresses national and international scientists, SMEs, large firms, regional economic development organisations and private interest groups. In this context, governments involve several target groups to generate spillovers. The advantage is such that the distribution of intellectual property rights from R&D or the management within R&D co-operations does not depend on policy makers but, instead, is left to the respective negotiations among the collaborative partners. Finally, policy makers expect spillovers because of international linkages, public awareness and more than just regional visibility of the relevant research, suitable to promote good practice and benefits.

Investigating ‘additionalities’

R&D policy evaluation

Evaluation processes help to assess the efficiency and effectiveness of political intervention and provide information useful for decision-making and for defining political strategy. The evaluation process is thereby bound to political objectives from the very beginning, and might remain so throughout the evaluation process. In line with the trend towards controlling and planning strategies in R&D policy, the demand for corresponding evaluations of the implemented technology policies has grown. OECD governments are becoming more aware of the necessity to analyse readily available information on R&D policies and their agents. Nowadays, this information is systematically stored in electronic databases. The main use of this data is to fulfil legal requirements (documentary evidence) and to give policy administrators descriptive statistical information. However, as these data are made available to evaluators, they offer a new field for insights into the impact of policies.

Ever since the first evaluation studies it has been emphasised that policy evaluation has to clarify the terminology used, the scope and perspectives as well as the frame of reference; it should also guarantee consistent indicators (Blank and Stigler, 1957; Lichtenberg, 1987). It is evident that in terms of measuring the success of a policy measure, different indicators may be applied depending on different perspectives: Policy makers may see high numbers of participants as a success indicator, firms may primarily view profits as indicator of success and consumers may judge success according to novelty and prices of the available products. Nevertheless, these cases all illustrate that an additional effect, called ‘additionality’, is usually expected.

However, empirical examinations on additional effects are based on quantitative database information and often neglect long-term behavioural changes, *e.g.* concerning organisational or strategic issues.

Concepts of measuring public funding additionalities

The measurement of additionality can be systematised into three concepts: 1) input additionality, 2) output additionality, and 3) behavioural additionality. *Input additionality* looks at firms' inputs, e.g. private R&D investments, and may be characterised by the question: do public R&D funds foster 'inputs' related to business R&D resources? This input-related concept analyses whether public R&D grants (partly) substitute for or complement private R&D investment. This strategy is being used in several OECD countries, with matching grants to qualify government-industry co-financing of R&D projects in the business sector. The concept of *output additionality* does not focus on changes in a firm's R&D spending, but instead analyses the 'output' of the firm's innovation process, e.g. new products or patents, after carrying out publicly and privately co-financed R&D. It analyses whether public R&D grants contribute to the outcome of firms' R&D processes. The concept of *behavioural additionality* is the newest of the three and was first introduced by Buisseret *et al.* (1995), who broadened the traditional additionality concept with the claim that "companies and institutions undertaking publicly sponsored projects are rarely left unchanged by the experience". This concept can be defined as "the change in a company's way of undertaking R&D which can be attributed to policy actions" (Buisseret *et al.*, 1995). Public funding might induce changes in firms' behaviour regarding their organisation or R&D strategy, e.g. companies redesign their long-term research strategies or their R&D management due to the publicly funded R&D project. The concept provides more detailed insight into operational modes, diffusion of know-how, appropriability, sustainability of R&D projects and financial issues (Georghiou and Roessner, 2000).

Measuring behavioural changes

One specific aspect of firms' R&D behaviour consists of their collaborative R&D activities. A firm decides whether or not to co-operate in R&D, and if it will, with which type of partner. The collaboration strategy is potentially influenced by public funding, which might encourage firms to extend their already existing collaborations or enter into new ones with new (types of) partners. Empirical studies on R&D partnerships usually analyse vertical and horizontal R&D co-operations or formal and informal arrangements, e.g. Kleinknecht and Reijnen (1992), Cassiman and Veugelers (2002), Tether (2002).

Just a few articles and empirical investigations deal with R&D co-operations as a part of firms' innovative behaviour *and* as a policy instrument: Branstetter and Sakakibara (2002) use empirical methods to evaluate the effects of participation in funded consortia on the research productivity of consortia members. Hall *et al.* (2003) seek a better understanding of the performance of university-industry partnerships by surveying a sample of pre-commercial research projects. Feldman and Kelly (2001) find that award-winning companies are better networked than those not awarded and exhibit a greater willingness to share research findings. Nevertheless, co-operative R&D *and* public funding has been examined empirically by only a few studies. Actually, most treatments have been based on case studies, or on the account of a few highly publicised co-operative R&D projects which are not representative.

The scope of the study presented here focuses on firms' behaviour in publicly funded collaborative R&D projects, thereby adding to the discourse on the restructuring of public R&D funding in Germany. We ask whether its most important tool, public R&D project funding, is adequate for influencing firms' collaborative behaviour:

- The first hypothesis is that public R&D funding stimulates firms to seek new R&D partners, *i.e.* different from the partners they usually co-operate with. We address whether public R&D funding is suitable to foster a change of firms' co-operative behaviour. For example, on the assumption that a company already co-operates in R&D with its suppliers and customers, we investigate if public funding supports these already existing co-operations or if collaborative R&D funding gives incentives for firms to test new types of partnerships, in particular multidisciplinary R&D collaborations.
- In the second hypothesis we examine firms' characteristics in terms of the duration of joint R&D once public funding has ended, that is, we test if business or science collaborations newly initiated within a publicly funded R&D project are lasting. As regards this matter, the government's rationale in subsidising R&D co-operations among industry and science is to improve the transfer and application of technologies and scientific knowledge, *e.g.* via the exchange of expertise among performers, and to stimulate and support innovations and patent activities. Collaborative public R&D schemes are designed to reduce different risk issues which prevent firms to co-operate in R&D. We assume that firms change attitudes and behaviour by discovering valuable assets in R&D co-operations. Hence, companies overcome prior reservations to partnering in their strategic field of R&D and maintain collaborative activities.

Public R&D funding in Germany

Origins and status of public R&D funding

In Germany, a complex system of public R&D funding was established in the 1970s to overcome technology gaps and, in the end, strengthen national and European competitiveness (Branscomb and Florida, 1997). Hence, public funding schemes extended into all areas of industry and technology. Today, the German research system is generally financed through targeted, short to medium-term funding (cost-shared project funding) and through medium or long-term basic funding of institutional research. In international comparison, the German R&D policy distinguishes itself mainly by its lack of supportive fiscal measures. At the federal level, R&D project funding of industry is almost exclusively provided by the Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Economics and Labour (BMWA).

As part of public R&D spending in German policy, the most important business-related stimulation tools are direct funding programmes. Direct project funding is characterised by the funding of a concrete field of technology. The purpose of such funding is to achieve high international standards of performance in selected areas of research and development (BMBF, 2002). In principle, such business R&D project funding is available to all domestic firms. However, each public R&D programme has specific characteristics, such as different application procedures, different requirements and different agencies which are responsible for funding proceedings. These agencies assist the federal ministries in funding concepts, advise potential applicants seeking support for research and offer consulting with respect to the exploitation of patents and licences. All in all, publicly funded R&D projects receive scientific, technological and administrative support from 16 'project management agencies' (BMBF, 2004).

Facts on Germany's R&D project funding

The importance of the direct R&D funding to the business sector is revealed by the number of funded companies and projects and the total amount of these grants. In the 1980s, an average of 1 623 projects per year was funded with an average amount of EUR 394 million (see Table 7.1).² The indicators show different changes in the following decades. The number of publicly funded projects steadily increased up to 4 080 projects in 2004. The number of funded companies more than tripled from 1980 to 2004.

Table 7.1. **Statistics on public R&D project funding to business in Germany (1980-2004)**

	'80-89	'90-99	2000	2001	2002	2003	2004 ¹
Average total number of grants	1 623	2 264	3 469	3 876	4 072	4 086	4 080
Average number of new grants	494	724	1 093	1 413	1 118	732	878
Single/individual recipients	1 171	586	644	628	538	520	527
Collaborative recipients	452	1 679	2 825	3 248	3 534	3 566	3 553
Average number of participants in collaborations	3.3	3.2	3.3	3.3	3.2	3.1	3.0
Average total R&D budget committed (millions of EUR)	393.7	318.1	395.6	414.9	397.8	380.9	362.9
Percent of total industry cost sharing (mean)	47.1	50.7	52.7	52.2	51.7	51.5	51.6
Average grant size for projects (millions of EUR)	0.242	0.149	0.114	0.107	0.098	0.093	0.089
Average grant size for individual projects (millions of EUR)	0.225	0.185	0.177	0.182	0.183	0.182	0.151
Average grant size for collaborative projects (millions of EUR) ²	0.334	0.136	0.100	0.093	0.085	0.080	0.080
Percent of grants to single/individual projects	72.2	25.9	18.6	16.2	13.2	12.7	12.9
Percent of grants to collaborative projects	27.8	74.1	81.4	83.8	86.8	87.3	87.1

1. Preliminary numbers.

2. Basis: single collaborative project.

Source: BMBF PROFI database (2005), calculations by ZEW; 1980 to 1989: West Germany; deflated time series amounts (1995=100).

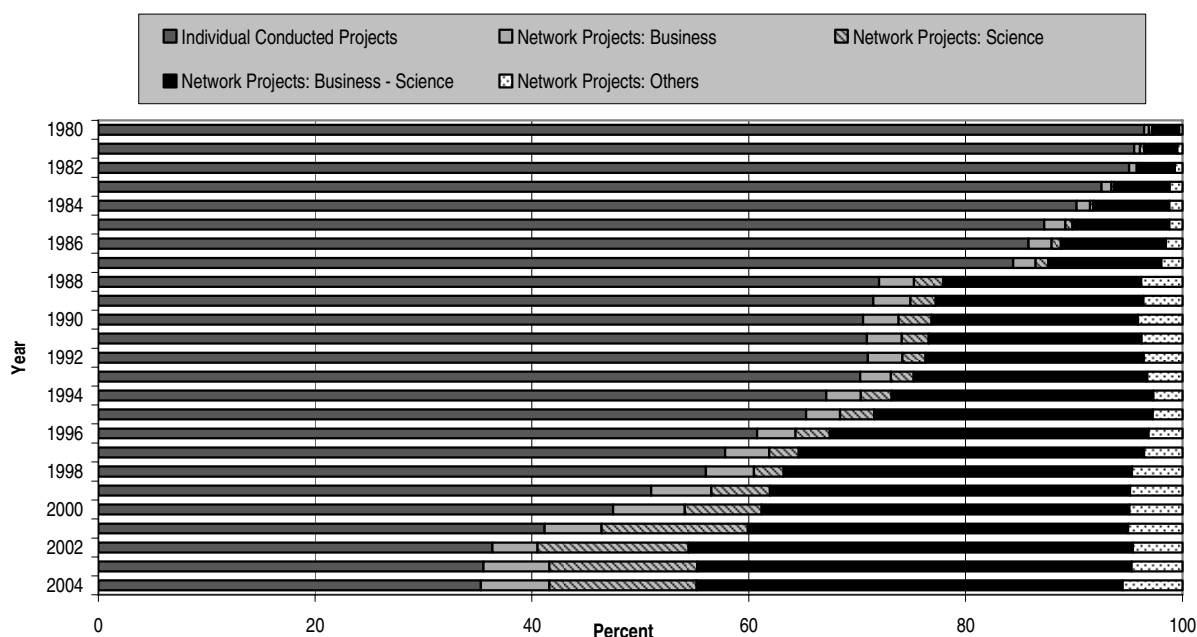
The federal government's total R&D budget available for spending on research active firms did not grow proportionally with the increase of awarded projects. Rather, the total R&D budget and therefore the average award size have been decreasing at the same time: From, on average, EUR 394 million awarded to private firms in the 1980s, in 2004 this amounts to about EUR 363 million (-8%), that is, more than twice as many projects and three times as many firms were funded with less money. Consequently, the average award size for R&D projects has been decreasing from EUR 242 000 to its present low of EUR 89 000 today. Furthermore, a shift took place in how the money was divided among the different technology areas. While the relative amount granted for projects of the areas environment/energy and transportation decreased in that time period, it was primarily the ICT sector which became more important. About 46% of the funding budgets was allocated to projects in the ICT sector in 2004.

2. Contract research and projects which are funded by 100% are not taken into account.

Collaborative R&D

At the end of the 1980s, German R&D policy emphasised the funding of projects conducted by networks rather than individual companies, motivating companies to learn from each other and pool their specific capabilities (BMBF, 1988). The trend towards collaborative projects is shown in Figure 7.1, which graphs all publicly funded projects of the business and science sector according to whether they are part of a network and, if so, which kinds of partners are involved.

Figure 7.1. Share of publicly funded individual and collaborative R&D projects (1980-2004)



Source: Calculation by ZEW based on the German federal government's database PROFI (2005).

In 1980 almost all of the funded projects were conducted by individual companies. This changed dramatically over time: The proportion of projects conducted in collaboration with two or more companies rose steadily, until in 2004 two-thirds of the projects were part of a network. The increase thereby applies to all types of collaborations, *i.e.* any combination of business networks and research institutes/universities, but it is by far the largest for networks of business companies and scientific institutions. This shift, as described so far, is evident also when the business sector is portrayed alone. While in the 1980s, about 72% of all projects were individual R&D projects, the proportion completely changed to the opposite of 81% of collaborative projects at the beginning of 2000 (see Table 7.1). Currently, about 87% of all publicly funded projects of the business sector are collaborative R&D projects. These joint research activities are carried out by an average of three different partners, such as other firms or scientific institutions.

Empirical model, data and descriptive statistics

Methodology

The goal of the empirical analysis is to determine *a)* whether public R&D funding is suitable to foster a change in firms' usual R&D partnerships and *b)* whether newly initiated collaborations within a publicly funded R&D project are lasting, even if public funding has ended.

a) Changes in firms' R&D partnerships due to public funding

To examine the first effect of involving new types of partners due to public funding, we will compare R&D collaborating firms. We distinguish firms without public funding from those which receive funds and investigate their R&D partnerships. Along with the German public funding procedures we analyse firms' R&D collaborations by 1) business-only, 2) science-only and 3) their involvement of a combination of both business and science. Policy makers expect changes in co-operative behaviour. Explicitly, a public funding stimulus for increasing the probability of R&D to co-operate in new R&D compositions is expected: companies which have previously co-operated solely in applied R&D with other firms, *e.g.* clients and/or suppliers (business partnerships) or firms which used to exclusively co-operate with universities (science partnerships) both gain incentives for their involvement in combined business-science partnerships. Although public R&D funding schemes supposedly reduce risks and allow companies, *e.g.* to try out new kinds of partnerships, the assumption of significant changes in the collaborative behaviour may be questioned.³

To avoid a possible selection bias, which occurs when participants in public measures differ from non-participants in important characteristics, we apply a matching approach (Heckman *et al.*, 1999). The matching is able to directly address the question, "What would a treated firm with given characteristics have done if it had not been treated?" Of the firms collaborating in R&D, treatment in our context applies for those which have *not* participated in a publicly funded R&D project. We investigate the potential change of collaborative behaviour that may arise from public funding. Our sample exclusively contains R&D collaborating firms, of which we are able to distinguish subsidised and non-subsidised R&D collaborations. The matching estimator balances the sample individually for each observation with respect to the variables included in the matching procedure. The fundamental evaluation question can be illustrated by an equation describing the average treatment effect on the treated:

$$E(\theta) = E(YT | S = 1) - E(YC | S = 1),$$

where *YT* is the outcome variable, that is the propensity to collaborate with different partners. The status *S* refers to the group: *S*=1 is the treatment group and *S*=0 the non-treated firms. *YC* is the potential outcome which would have been realised if the treatment group (*S*=1) had not been treated. The problem is obvious: While the outcome of the treated firms in case of treatment, $E(YT|S=1)$, is directly observable, this is not the case for the counterpart. How would these firms have behaved if they had not received the treatment? $E(YC|S=1)$ is a counterfactual situation which is not observable and, therefore, has to be estimated. In the case of matching, this potential outcome is constructed from a

3. Germany's public funding schemes favour collaborative research projects but do not predetermine the type of collaborative partner.

control group of participants (collaborating and publicly funded firms). The matching relies on the intuitively attracting idea of balancing the sample of programme participants and comparable non-participants. Remaining differences in the outcome variables (business-only, science-only and business-science partnerships) between both groups are then attributed to the treatment (Heckman *et al.*, 1997).

b) Continuation of firms' new R&D partnerships even if public funding ends

What happens with an R&D partnership when public funding ends? The predominant question is whether the partners continue to collaborate or if the established network dissolves, with special attention paid to newly initiated collaborations. This suggests that collaboration need not be restricted to the funded project period, but that companies could continue joint activity, *e.g.* in another project or in other respect. They might especially decide to do so in case the companies considered the funding and co-operation as valuable.

Due to potential heterogeneity among firms, technologies or grants, we apply a multivariate approach (bivariate probit model⁴) to test the hypotheses. This enables us to control for effects of several variables in the analysis. Accordingly, we estimate simultaneously the likelihood of the continuation of co-operation with science and co-operation with business. On the basis of the estimation results we check whether the variable for the newly initiated co-operation still have a significant impact on the continuation of the R&D partnerships (Hypothesis 2).

Data and telephone survey

The company data used in the following empirical analysis is based on the German Community Innovation Survey database (MIP/CIS), the German Federal Government's R&D funding database (PROFI), the German Patent Office database (DPMA) and Computer Aided Telephone Interview (CATI) data.

In an initial step we use data from the Mannheim Innovation Panel (MIP), an annual innovation survey conducted by the Centre for European Economic Research (ZEW) on behalf of the BMBF since 1993. The MIP represents the German part of the European Commission's Community Innovation Survey (CIS). The data cover the manufacturing sector and selected service sectors. We use the 2001 and 2004 waves of the MIP as the only to contain data on R&D co-operations and funding. This means the surveyed information corresponds to the years 2000 and 2003. Sampled firms are only those which maintain R&D co-operation and, on top of that, named the type of their co-operation partners. Since only the innovative firms were asked the questions on co-operation the sample is restricted to firms with innovative activities. In order to achieve valid results, it is decided to limit the sample to manufacturing firms and, moreover, to companies with less than 5 000 employees.⁵ In a second step, we merge this firm level data with the federal government's R&D funding database (PROFI). This database contains all federal public R&D funding activities carried out in Germany since 1980s. Because the analysis deals with behavioural changes concerning R&D co-operations, only collaborative research projects are considered. In a third step, information on patents is extracted from the DPMA database which contains the patenting activities in Germany since 1980. As

4. For a description of bivariate probit models see, *e.g.* Greene (2003).

5. As the matching relies on the idea of comparing similar observations, it is decided to restrict the sample to companies with less than 5 000 employees because it is not very meaningful to look for similar firms when they are larger than this threshold.

both the DPMA and the PROFI databases are census data, the sample is determined by the MIP. In the end, we count 659 German firms to be used for the following estimations.

In preparation for the telephone survey on behavioural patterns, cases were selected where the publicly funded R&D projects (PROFI) expired between 2002 and 2004. This time period guarantees a higher probability of contacting the responsible R&D managers involved in the R&D funding and performing process. According to the study's research objectives, a questionnaire was designed to be used in a telephone survey. The CATI system was chosen because of its high flexibility in reporting interviews and higher response rates compared to mail surveys. The telephone interview was structured in four different thematic fields related to the dimensions of behavioural additionality.⁶ For the behavioural assessment of the impact of publicly funded R&D projects on collaborations, the interviewees were asked about their status of co-operation with respect to public funding. Finally, the CATI system randomly selected interview partners from a pool of 524 firms. Within eight weeks, 1 363 calls were made by research fellows and experienced students. Every company was called an average of 2.6 times for different reasons, such as the responsible R&D project manager being unavailable. In summary, 39% of the contacted R&D managers participated in the survey and for 142 firms a full set of data is available.

Variables and descriptive statistics

On the basis of the MIP data, 659 collaborative R&D performers are distinguished into recipients of public R&D funds and companies who co-operate in R&D without public funding. Within the CATI survey, 142 publicly funded R&D collaborating firms reported on internal R&D activities, explained their intentions to participate in public R&D programmes and gave reasons for collaborating (Table 7.2).

In order to test the hypotheses we use different sets of variables. Due to the empirical findings on collaborations we distinguish three kinds of R&D partnerships to examine the first hypothesis:

- a) Business-business co-operation (BCOP): a firm collaborates only with other firms.
- b) Business-science co-operation (SCOP): a firm collaborates only with science.
- c) Business-science&business co-operation (SBCOP): a firm collaborates with other firms and science.

The descriptive statistics of the total survey of 659 firms show that 57% of these companies participate in a business-science&business (SBCOP) co-operation (see Table 7.2). About 24% of all firms only co-operate with science (SCOP) and about 19% have partnerships only with business (BCOP). In the sample of collaborating firms most companies have been publicly funded by the Federal State within programmes or initiatives (63%).⁷

6. 1) Significance and contribution of the respective publicly funded R&D project; 2) impact of the publicly funded R&D project on collaborations; 3) general strategies underlying the acquisition and conduct of firms' R&D projects, and 4) general questions about R&D activities in the considered firm.

7. The sample is restricted to co-operative firms with innovative activities since only the innovative firms were asked questions on co-operation.

Table 7.2. Descriptive statistics of the German survey (659 observations)

Variables			Mean	Std. dev.	Min	Max
<i>FUND</i>	Participants of public R&D funding	FUND=1	0.625	0.484	0	1
<i>BCOP</i>	R&D collaboration with business	BCOP=1	0.188	0.391	0	1
<i>SCOP</i>	R&D collaboration with science	SBCOP=1	0.238	0.426	0	1
<i>SBCOP</i>	R&D collaboration with science and business	SBCOP=1	0.573	0.495	0	1
<i>ln(TURN)</i>	Log of turnover		2.945	1.967	-2.973	7.616
<i>AGE</i>	Firm's age		33.158	37.714	0	58.006
<i>EXINT</i>	Export intensity		0.334	0.262	0	1
<i>RDNO</i>	No regular R&D activities	RDNO=1	0.049	0.215	0	1
<i>RDOC</i>	Occasional R&D activities	RDOC=1	0.158	0.365	0	1
<i>RDRE</i>	Regular R&D activities	RDRE=1	0.793	0.405	0	1
<i>PATDL</i>	Patent dummy (lagged variable)	PATDL=1	0.200	0.401	0	1
<i>EAST</i>	Eastern Germany (region)	EAST=1	0.319	0.466	0	1
<i>YR</i>	Year 2003	YR=1	0.581	0.494	0	1
<i>IND1</i>	NACE Codes: 10, 11, 12, 13, 14, 26, 40, 41, 45	IND1=1	0.085	0.280	0	1
<i>IND2</i>	NACE Codes: 15, 61, 17, 18, 19	IND2=1	0.039	0.195	0	1
<i>IND3</i>	NACE Codes: 20, 21, 22, 36, 37	IND3=1	0.044	0.205	0	1
<i>IND4</i>	NACE Codes: 23, 24, 25	IND4=1	0.159	0.365	0	1
<i>IND5</i>	NACE Codes: 27, 28, 29, 34, 35	IND5=1	0.382	0.486	0	1
<i>IND6</i>	NACE Codes: 30, 31, 32	IND6=1	0.112	0.316	0	1
<i>IND7</i>	NACE Codes: 33	IND7=1	0.179	0.384	0	1
<i>SCOPC*</i>	Collaboration with science continued	SCOPC=1	0.718	0.451	0	1
<i>BCOPC*</i>	Collaboration with industry continued	BCOPC=1	0.746	0.437	0	1
<i>ln(TURN)*</i>	Log of turnover		1.558	2.048	-2.017	7.093
<i>ln(GRANT)*</i>	Log of amount of grant		11.990	0.930	9.358	14.803
<i>SCOPI*</i>	Collaboration with science new initiated	SCOPI=1	0.430	0.497	0	1
<i>BCOPI*</i>	Collaboration with business new initiated	BCOPI=1	0.634	0.483	0	1
<i>BEGIN*</i>	Accelerated beginning of project	BEGIN=1	0.542	0.500	0	1
<i>EXT*</i>	Extended project scope	EXT=1	0.556	0.499	0	1
<i>EAST*</i>	Eastern Germany (region)	EAST=1	0.394	0.490	0	1
<i>SERVICE*</i>	Service sector (industry)	SERVICE=1	0.338	0.475	0	1
<i>TEC1*</i>	Environment; Energy; Transportation	TEC1=1	0.268	0.444	0	1
<i>TEC2*</i>	Materials	TEC2=1	0.155	0.363	0	1
<i>TEC3*</i>	Life Science	TEC3=1	0.077	0.268	0	1
<i>TEC4*</i>	ICT	TEC4=1	0.338	0.475	0	1
<i>TEC5*</i>	Cross-sectoral activities; Education/Science	TEC5=1	0.162	0.370	0	1

Note: *N=142 collaborating and publicly funded firms involved in the detailed CATI survey.

Source: ZEW databases (2005).

Collaborating participants of public R&D funding are labelled by a dummy variable (FUND). If we just focus on these publicly funded R&D collaborating firms, we observe a slightly higher tendency in business-science&business co-operations (SBCOP): 65% of these firms have R&D co-operations with science and industry, 27% co-operate only with science and 8% of all firms only have business R&D partnerships.

In the analysis we take several characteristics of R&D collaborating firms into account as exogenous variables: Since larger companies have a higher probability of co-operating in general and therefore tend to have more experience with co-operations, it is probable that they already maintain or have previously maintained co-operations with their possible partners. For this reason, we control for firm size in terms of the log of turnover, whereby turnover is measured in millions of euros (TURN). Firm's experiences on markets and with competitors are controlled by their age (AGE). Companies differing in the regularity of their R&D activities might be heterogeneous with respect to their R&D organisation and thus might select a different set of partners. In order to capture this, we use three dummy variables: measuring whether firms exhibit no (RDNO), occasional (RDOC) or regular R&D (RDRE) activities. Empirical studies suggest that regular R&D activities have a positive influence on firms' co-operation behaviour (Cassiman and Veugelers, 2002). RDNO serves as a base category. Further variables are used to control for intellectual property rights and firms' experiences in foreign markets: A lagged patent dummy (PATDL) is used to capture the competence to apply for patents and the export intensity (EXINT) indicates the degree of foreign sales. All regressions include a dummy which denotes eastern German firms, as they may face different conditions due to the ongoing transformation process of the eastern German economy (EAST). We also include a dummy variable indicating the year of observation (YR2003) and industry variables (IND1-IND7)⁸ to take into account distinctive features in different industries.

Through the telephone survey, additional information becomes available to complement the MIP survey data. This information is used to test the second hypothesis, whether newly initiated business or science collaborations within a publicly funded R&D project are continued after the funding ends. We distinguish two kinds of partnerships which have been continued after funding ended:

- a) Business-business co-operation continued (BCOPC): a firm's R&D collaboration with other firms continues.
- b) Business-science co-operation continued (SCOPC): a firm's R&D collaboration with science continues.

For firms which initiate a new co-operation with business or science in the publicly funded R&D project, the dummy variables SCOP1 and BCOP1 are generated. It is expected that newly initiated co-operations are less likely to be continued in comparison to longer-established relations. The dummy variable BEGIN indicates whether the funding of an R&D project had accelerated the beginning of the project. An extended project scope due to funding is captured by the dummy variable EXT. Both are expected to have a positive impact on the decision to continue co-operation. The total amount of the received subsidies in the funded project (GRANT, in millions of euros) may have an impact on these decisions. We capture impacts specific to a particular funding area by including five technology dummies (TEC1-TEC5). The reference category consists of

8. The industries are aggregated in terms of the NACE Rev.1 as follows: IND1: 10-14, 26, 40, 41, 45; IND2: 15-19; IND3: 20-22, 36, 37; IND4: 23-24; IND5: 27-29, 34, 35; IND6: 30-32; IND7: 33.

projects belonging to ‘cross-sectoral activities’ or ‘education/science’ (TEC5).⁹ Furthermore, firm-specific characteristics are included. We control for the size of the firm with the logarithm of turnover (TURN). Firms which are most active in the service sector are labelled by the dummy variable SERVICE. We include the dummy EAST indicating that the location of the firm is in eastern Germany.

Empirical results

The empirical analysis sheds light on two aspects of companies’ behaviour: First, we perform a neighbour matching estimation (Mahalanobis metric) to consider a possible selection bias comparing publicly funded R&D collaborating companies and those not-publicly funded. We investigate whether not-publicly funded firms collaborate in R&D with a different set of partners (firms from business, science or both) compared to the counterfactual situation, *i.e.* to the situation that these firms would have been publicly funded. Second, we investigate collaboration behaviour when public funding has ended. This analysis is based on the group of publicly funded and R&D collaborating companies which participated in the CATI survey.

Changes of firms’ R&D partnerships due to public funding

Table 7.3 shows the matching results and the considered characteristics of the different firm groups: R&D collaborating but not publicly funded firms as “treatment group” (247 firms) and R&D collaborating and publicly funded firms (412 firms) as controls. Before proceeding the matching, a probit model on not-publicly funded firms’ characteristics (FUND) was estimated.¹⁰ The results show that not-publicly funded firms have a smaller probability of carrying out regular R&D activities, are slightly older and have a higher probability of being based in West Germany. The propensity score of this estimation (PSCORE) is used within the matching procedure. The Mahalanobis metric restriction is defined by size (TURN), industry group dummies (IND1-IND7), the regularity of R&D activities (RDNO, RDOC, RDRE), the region (EAST) and the lagged patent application dummy (PATDL). Some companies might have been chosen several times in the matching due to a best match regarding the defined characteristics.

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9. The funding areas are aggregated as follows: environment/energy, materials; life science, cross-sectoral activities/education/science.
 10. The matching procedure is described in detail, *e.g.* by Czarnitzki and Fier (2002). The results of the probit estimation can be found in Fier *et al.* (2005).

Table 7.3. Matching results on R&D collaborating firms (247 observations)

Variable	Sample	Mean		% bias	p-value of two sided t-test
		Treated (not publicly funded)	Control (publicly funded)		
FUND	Unmatched	1	0		
	Matched	1	0		
PSCORE	Unmatched	0.501	0.297	104.1	0.000
	Matched	0.501	0.494	3.3	0.719
Ln(TURN)	Unmatched	3.451	2.641	42.9	0.000
	Matched	3.451	3.494	-2.3	0.780
PATDL	Unmatched	0.190	0.206	-4.0	0.619
	Matched	0.190	0.182	2.0	0.818
EAST	Unmatched	0.146	0.422	-64.3	0.000
	Matched	0.146	0.130	3.8	0.602
RDNO	Unmatched	0.097	0.019	33.6	0.000
	Matched	0.097	0.073	10.5	0.334
RDOC	Unmatched	0.215	0.124	24.4	0.002
	Matched	0.215	0.198	4.3	0.657
RDRE	Unmatched	0.688	0.857	-41.0	0.000
	Matched	0.688	0.729	-9.8	0.323
BCOP	Unmatched	0.364	0.083	71.8	0.000
	Matched	0.364	0.130	59.8	0.000
SCOP	Unmatched	0.190	0.267	-18.3	0.025
	Matched	0.190	0.206	-3.9	0.653
SBCOP	Unmatched	0.445	0.650	-42.1	0.000
	Matched	0.445	0.664	-44.8	0.000

Note: Eight industry dummies and a dummy variable indicating the year of the survey are not reported. After matching the respective means they are not significantly different.

Table 7.3 shows the share of companies collaborating in R&D along the variables: strictly business (BCOP), science-only (SCOP) and the combination of business-science partnerships (SBCOP). Moreover, the table lists not-publicly funded firms (treated) and publicly funded firms (controls) before (unmatched) and after (matched) the matching.

On the question how not-publicly funded firms on average would have behaved if they had been publicly funded, it is found that R&D funding is, in particular, a stimulating tool to link science into industry R&D partnerships: Publicly funded collaborative R&D is suitable to change previously business-to-business oriented firms to involve science in their R&D activities.

Companies which co-operate solely in R&D with industry, such as clients and/or suppliers (BCOP), change this business-to-business R&D strategy: While 36% of the non-funded firms co-operate in only business-to-business relationships, only 13% (before matching: 8%) of firms would choose this business-to-business R&D strategy if they received public grants. In this respect, we reject the critical vision that public funding has no influence on R&D networking flexibility. We find evidence that business-to-business R&D collaborating firms shift into science-business partnerships due to public funding, i.e. involving science partners as new members in their R&D collaborations. The results show that 45% of the not-publicly funded firms co-operate in R&D with science and

industry. This share would have increased up to 66% if public funding had taken place. Co-operations with science as an additional partner in former business-to-business R&D partnerships are stimulated by the tendency of the public R&D policy to award multi-disciplinary R&D co-operation. This is consistent with the results for the firms which already co-operate with science. Firms which exclusively co-operate in R&D with science do not show significant differences in their co-operation behaviour due to public funding (SCOP): 19% of non-publicly funded firms solely co-operate with science and this share would have been constant even if public funding had taken place. However, we are not able to observe if science calls business to participate in publicly funded R&D collaborations or if industry calls science into publicly funded R&D partnerships.¹¹

Continuation of firms' new R&D partnerships after public funding has ended

In order to test which determinants influence the probability of continuing collaborations when the public R&D project funding has ended, we distinguish co-operations with science from those with business. In the bivariate probit model the endogenous variables are dummy variables indicating whether the collaboration with science (SCOPC) and the collaboration with business (BCOPC) were continued. Table 7.4 shows the results of the regression model.

Table 7.4. **Bivariate probit estimation results on continued collaborations**

Variables	Collaboration with science continued (SCOPC)			Collaboration with industry continued (BCOPC)		
	Coeff.		Std. err.	Coeff.		Std. err.
$\ln(\text{GRANT})$	0.309	**	(0.140)	0.082		(0.141)
<i>SCOPI</i>	-1.107	***	(0.266)	-		
<i>BCOPI</i>	-			-0.417		(0.274)
<i>BEGIN</i>	0.294		(0.263)	0.900	***	(0.270)
<i>EXT</i>	0.817	***	(0.280)	0.081		(0.267)
$\ln(\text{TURN})$	0.086		(0.080)	0.114		(0.082)
<i>EAST</i>	0.650	*	(0.355)	0.237		(0.321)
<i>SERVICE</i>	0.239		(0.330)	0.373		(0.335)
<i>TEC1</i>	0.114		(0.470)	-0.966	*	(0.512)
<i>TEC2</i>	-0.300		(0.499)	-1.236	**	(0.535)
<i>TEC3</i>	-0.114		(0.591)	6.681		(0.562)
<i>TEC4</i>	0.244		(0.471)	-1.052	**	(0.504)
Number of obs.	142					

Note: Significant at the 1% level (***), 5% level (**), 10% level (*).

Source: Survey data 2004 (Fier *et al.*, 2005a).

11. In a broader German survey, Czarnitzki *et al.* (2003) explicitly asked who triggered the involvement in public R&D funding schemes. Most interviewees report that science was the driving force in bringing firms into publicly funded R&D partnerships.

Regarding hypothesis two, it was found that co-operations with scientific institutions which were newly initiated for the funded project are less likely to be continued after funding has ended than co-operations which already existed prior to the funded project (SCOPI). This is not surprising since long-term partnerships can mean improved co-operation on a more trustful basis, making continuation rather plausible. On the other hand, in new co-operations there is a higher risk that the collaboration does not perform as intended. While this effect is significantly negative regarding the continuation of co-operations with science, it is not significant regarding the continuation of co-operations with business (BCOPI), which might be connected to different reservations regarding the type of R&D partner. Firms have apparently less hang-ups co-operating with science than with industry. It costs the company a great effort to co-operate with another company for the first time since concerns in general are more pressing, *e.g.* that knowledge might leak out to a competitor. Accordingly, partnerships once established between businesses are more sensitive. Hence, it is maybe more likely to begin a co-operation with science, but also less problematic to end it again.

Some firms broadened their initial research spectrum due to public funding. This extension of the R&D project volume (EXT) has a positive influence on the continuation of collaborations with science. Due to the complexity of the interdisciplinary projects, further fields of research might evolve. The partners continue to work on issues even after public funding has ended. The positive effect of the extension of the project volume on the continuation of the collaboration does not apply for co-operations with business.

Due to the funding, about half of the firms were able to expedite the beginning of the project since potential financial gaps and negotiations were reduced. With regard to business-business co-operations the faster initial project start (*BEGIN*) increases the likelihood of continuing the collaboration with business partners. This observation could be explained by the fact that a comparative advantage towards competitors could be realised because of the earlier project start. In order to maintain this advantage, the business-business partnership is more likely to be continued.

Overall, if the companies gain these specific experiences, the likelihood of continuing the corresponding collaboration is higher.

We find a significant effect on the probability of continuing collaboration with scientific institutions by the total amount of awarded R&D funds (*GRANT*). Large-scale R&D project grants tend to be more complex so that on the one hand the scheduled end could not be kept and the collaborative project had to be continued. On the other hand, additional research topics emerge due to the complexity as argued above. The funding volume does not have an influence on continuing business-business collaboration (*BBC*) after the funding has ended.

A firm's location in eastern Germany has a positive effect on the continuation of collaboration with science. Other firm characteristics like size ($\ln(\text{TURN})$) or belonging to the service sector (*SERVICE*) do not affect the probability of continuation of any type of co-operation. Overall, firm characteristics do not play a crucial role in the continuation of collaboration, only in the decision of co-operating at all and with whom.

Conclusions

Publicly funded business R&D has become a major objective of innovation policy in many OECD countries. Since the European Commission set up the 3% target, *i.e.* an increase of the investment in research and development activities to 3% of GDP by 2010, Germany's government and industry were put in charge to take action. Along these lines, the corresponding 'Agenda 2010' action plan set up by the German government is not only seen as a significant motivator for national but also European innovation capabilities (European Commission 2002, Deutsche Bundesregierung 2003).

From the point of view of a scientist as well as a policy maker, understanding the mechanisms and impacts associated with public intervention, such as direct R&D project funding, is of particular importance. Its increasing relevance can be ascribed to decreasing government budgets and the necessity to design policy measures more efficiently. The general question arises as to whether public intervention is required at all. With respect to R&D policy and funding procedures, Germany has emphasised the projects conducted by networks rather than individual companies since the 1990s. Today, most R&D policy measures are designed as collaborative research programmes.

This research study looks at behavioural effects of publicly funded R&D in the field of collaborative business R&D in Germany. We analyse different types of collaborative research due to public R&D funding. First, we investigate whether public R&D funding stimulates firms to participate in new kinds of R&D co-operation. Second, we examine whether newly initiated collaborations within a publicly funded R&D project are more likely to last than already existing co-operations after public funding has ended. The research is based on different databases and a telephone survey. The sample consists of observations for 659 collaborating German firms.

It is found that R&D funding is, in particular, a stimulating tool to link science into industry R&D partnerships. Publicly funded collaborative R&D is suitable to change co-operative behaviour: firms which exclusively co-operate with other business companies involve science as a new partner in their R&D activities due to the funding. Hence, public funding achieves its aim of broadening R&D networks, in the expectation of strengthening spillovers and innovativeness.

However, we also show that newly initiated R&D co-operations with science are less likely to be continued after funding has ended compared to already existing co-operations. The dissolution of the newly established R&D partnerships might be due to several factors. First of all, new co-operations bear a higher risk that the collaboration does not perform as intended compared to already existing co-operations. Furthermore, a continuation of the co-operation might fail due to unsolvable financial gaps. In addition, some firms might not be willing to completely finance their R&D projects with equity because of a high innovation risk. Moreover, most co-operative projects are bound to specific individuals, so that the collaboration might not be kept up if these individuals drop out of their institution or firm. Overall, public funding tends to integrate science into business R&D partnerships, but the newly established networks are not necessarily lasting after funding has ended.

In conclusion, it should be noted that general firm characteristics – often used to define awardees for public funding schemes – do not play a crucial role for the continuation of collaborations. Further studies should therefore focus on individuals and their behaviour since they seem to be most relevant for continuing a trusting and efficient R&D partnership.

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Chapter 8

BEHAVIOURAL ADDITIONALITY OF PUBLIC R&D FUNDING IN JAPAN

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Abstract. This chapter reviews results of recent evaluations of government R&D funding programmes in Japan that provide useful insight into behavioural additionality effects on firms. One such trial is the follow-up monitoring activity of the New Energy and Industrial Technology Development Organisation (NEDO), which found that participation in projects funded by NEDO changed firms' attitudes towards more challenging, high-risk R&D projects. Another survey on national project management conducted by Sakakibara *et al.* indicates that use of government R&D subsidies induced changes in several dimensions of firms' R&D behaviour, such as their willingness to pursue more challenging, fundamental research; their patterns of human resource development; and levels of networking and co-operation. Based on these preliminary findings, the chapter identifies policy issues that should be addressed by the Japanese government in the future and makes recommendations for future research on behavioural additionality.

Background

The Japanese national innovation system is characterised by a rather small government contribution to R&D investment. Moreover, its management is largely based on the outdated linear model, and the system tends to be sensitive only to direct input/output measurement of R&D activity. The fraction of the government's R&D budget for financing business R&D is particularly small and little attention has been paid to its evaluation.

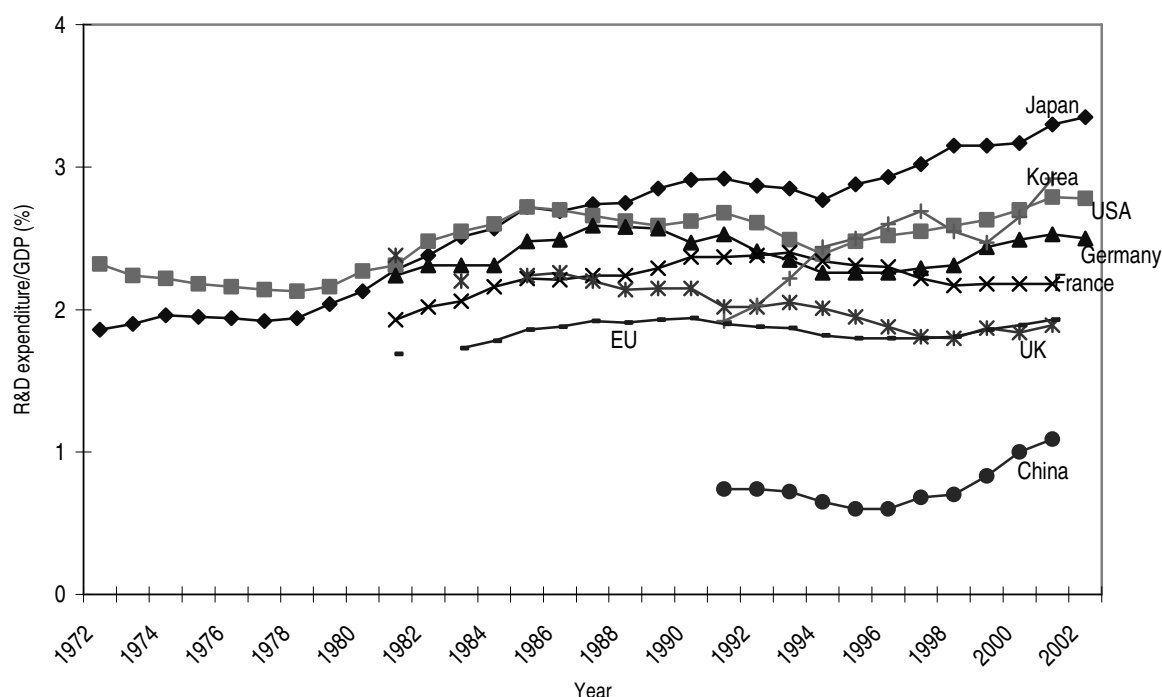
More recently, however, the Japanese government has come to acknowledge the need to improve and enforce the national innovation system in order to enhance industrial competitiveness. R&D activities in different sectors should be better linked, and government assistance should play a more affirmative role through improved management and evaluation cycles. Evaluation of behavioural additionality in combination with other types of evaluation would be useful in estimating the outcome of governmental support, including indirect effects. Furthermore, it can help the government in promoting accountability in its science and technology policy.

Unfortunately, there is no research or survey that focuses as such on the evaluation of behavioural additionality of government support to R&D activities in Japan. The results of some recent evaluation trials by funding agencies and research projects can, however, provide useful insight into the behavioural additionality of firms that have been awarded government subsidies. This report provides a brief overview of the current situation with respect to government financing of business R&D in Japan, the behavioural additionality effects observed in preliminary research, and future challenges and recommendations.

Government financing of business R&D in Japan

Japan ranks third among OECD member countries in the ratio of R&D expenditure to GDP – an index that policy makers sometimes use as a political objective (Figure 8.1). This represents fairly good performance and a high level of input into R&D activities. In comparison with other countries, however, the share of total R&D expenditure financed by the government is very low in Japan, and approximately half of all government R&D funding is allotted to universities – the highest share among all OECD members.

Figure 8.1. Ratio of R&D expenditure to GDP



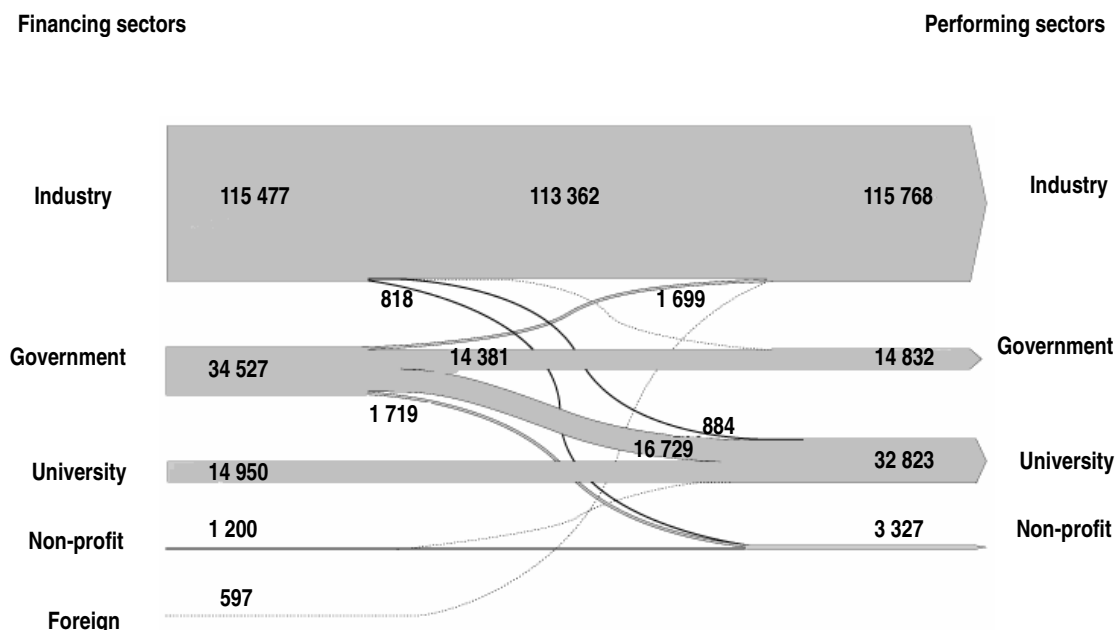
Source: NISTEP (2004), Figure 6-1-3.

In terms of the flow of R&D funding among economic sectors, almost all government funds are utilised by universities (typically national universities) and the government sector (typically national laboratories) (Figure 8.2). The Japanese system is, in general, characterised by weak linkages between the public and private sectors. Only some 1.5% of government R&D funding (JPY 170 billion) is allotted to the industrial sector, which is the lowest share among all OECD members. Therefore, the Japanese government is typically regarded as a self-sufficient R&D performer, rather than as an R&D sponsor.

The share of the industrial sector in the gross domestic expenditure on R&D in Japan increased during the 1980s. Although it decreased marginally after the crash of the bubble economy in 1991 and continued to decline until 1995, it has started to show a gradual increase again in recent years. On the other hand, the share of the government sector decreased during the 1980s and has remained unchanged to date.

Figure 8.2. **R&D expense flow between sectors in Japan**

(FY 2002, in JPY 100 million)

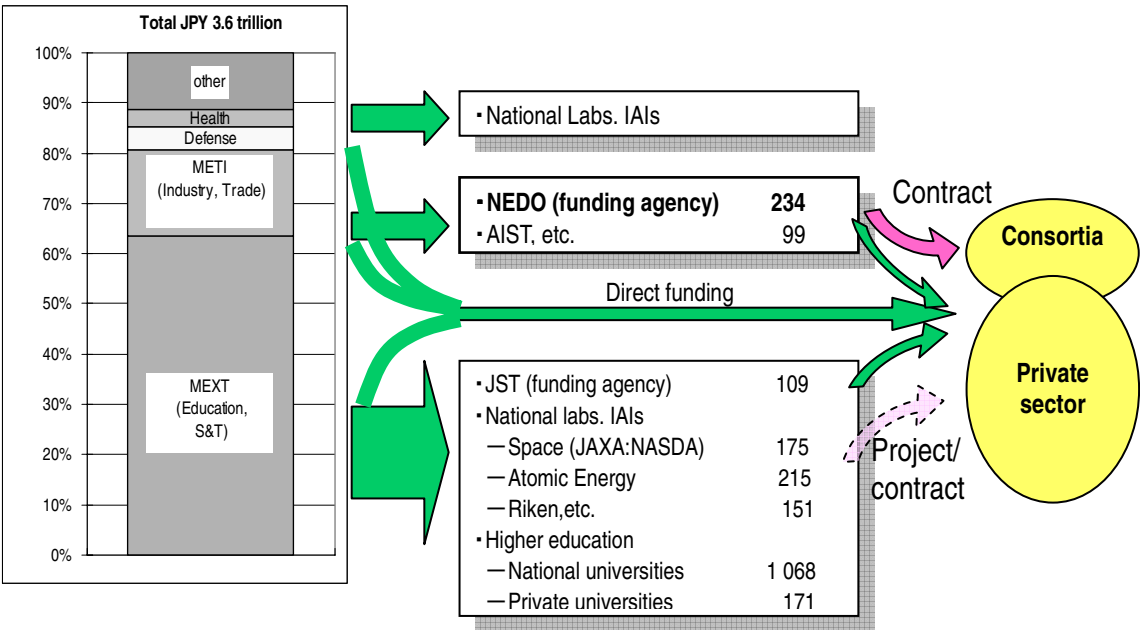


Source: NISTEP (2004), Figure 6-1-8.

The Japanese government launched the first Science and Technology Basic Plan in 1996. This plan set the target for the total governmental R&D expenditure at JPY 17 trillion for fiscal years 1996 to 2000. This plan successfully achieved its target in terms of R&D expenditure, and a second (more ambitious) plan was adopted in 2001.

The government budget for science and technology comprises the budgets for almost every ministry and agency. Among these, the largest is that of the Ministry of Education (MEXT), accounting for 63.7% of the total budget, followed by that of the Ministry of Economy, Trade and Industry (METI), which accounts for 17%. The majority of MEXT’s budget is spent supporting the activities of national universities and laboratories. Primary awardees of funding from the Japan Science and Technology organization (JST), the funding agency under MEXT, continue to be universities and public bodies. Although these government funds flow to the private sector through various routes, the most significant route is that through the funding agency under METI known as New Energy and Industrial Technology Development Organisation (NEDO). NEDO’s budget for the fiscal year 2003 was approximately JPY 234 billion. Approximately two-thirds of this is expected to be spent on R&D projects, primarily through R&D consortia and individual firms in the form of contracted research (see Figure 8.3).

Figure 8.3. Major routes for government financing of business R&D (FY 2003)



Source: NISTEP (2004).

The following section will focus on the recent experimental evaluation activity at NEDO in order to extract information with respect to the behavioural additionality effects of NEDO’s funding.

Follow-up monitoring and evaluation at NEDO

NEDO started a new initiative in 2003 to monitor the post-project activities of project participants and assess the impact of national R&D projects. It is also expected to provide feedback for improved R&D management. The initiative comprises three stages: a simplified monitoring stage, a detailed monitoring stage and an evaluation stage.

During the simplified monitoring stage, the post-project activities of project participants are monitored as follows:

- Achievements with regard to the practical application of R&D are reported every year in a simplified manner for a period of five years as a general rule.
- In addition to project status, relevant information including patents, licensing, publications, awards, competitive situation, level of priority in the firm, etc., is reported.

In case the R&D achievements find practical applications or are commercialised, or if the R&D activities are abandoned during the simplified monitoring period or experience significant delays, then the following detailed information is collected:

- Information from interviews and detailed questionnaires.
- Sales amounts of relevant products and their market share (if commercialised).
- The reason for interruption (if abandoned).
- Spillover effects and indirect effects identified during various R&D stages.

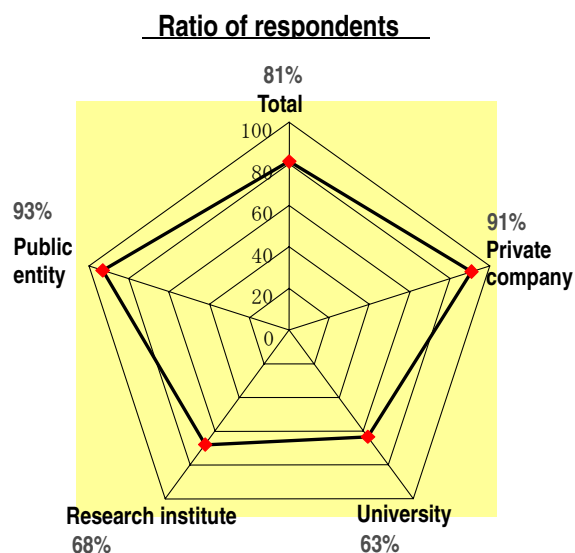
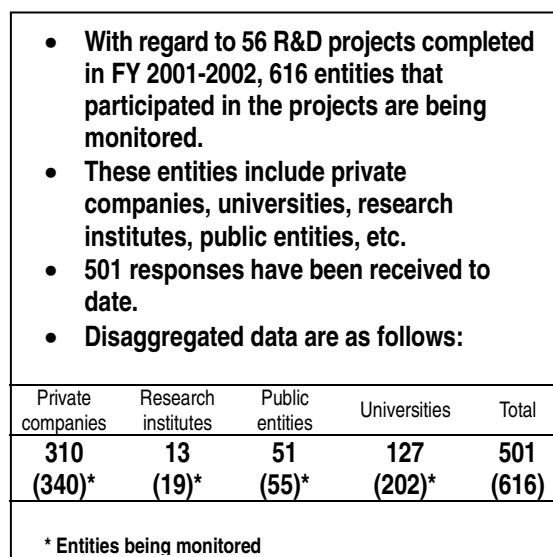
Preliminary results of simplified monitoring (provisional data collected by the end of 2004)

With regard to 56 R&D projects completed in FY 2001-2002, 616 participating entities were monitored. These entities included private firms, universities, research institutes, public entities, etc. To date, 501 responses have been received (see Figure 8.4).

Among the 310 private firm respondents, 196 (63%) carried out post-project activities and accounted for 91% of all monitored projects. In addition, 42 firms (21%) had already reached the stage of practical application or commercialisation of their R&D achievements. The remaining 154 firms included 75 firms that were in the development stage, 69 in the research stage, and 10 firms that implemented post-project activities but eventually abandoned them (see Figure 8.5).

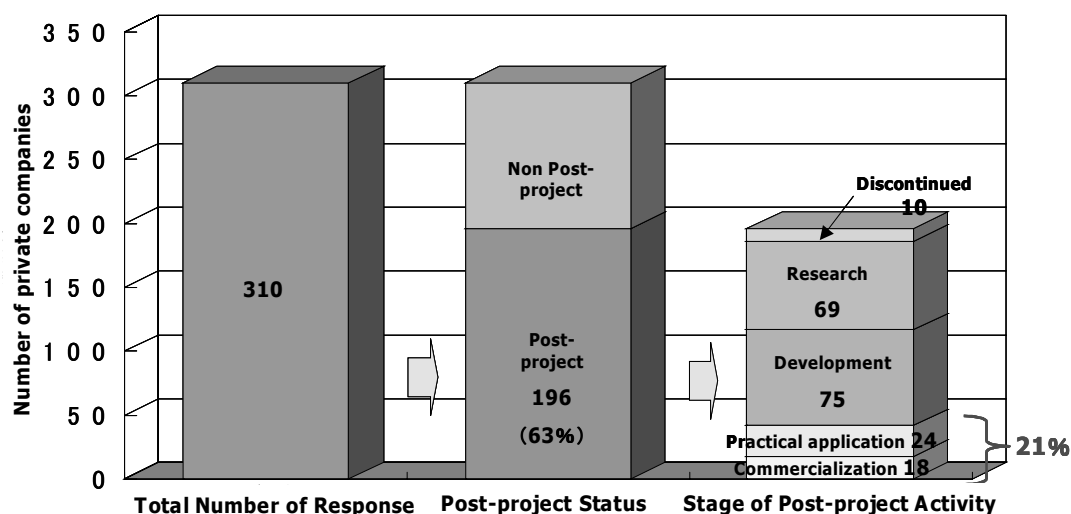
Forty-two firms that reached the practical application stage were closely monitored. Interviews were conducted using a questionnaire with approximately 90 questions in the following four categories: business details, intellectual property rights and spillover effects, contribution of NEDO's management, and other issues. The following are some of the results that appear to be of significance with respect to behavioural additionality (see Figure 8.6).

Figure 8.4. Respondents to the simplified monitoring in 2004



Source: New Energy and Industrial Technology Development Organisation (NEDO) of Japan.

Figure 8.5. Post-project activities of respondent firms



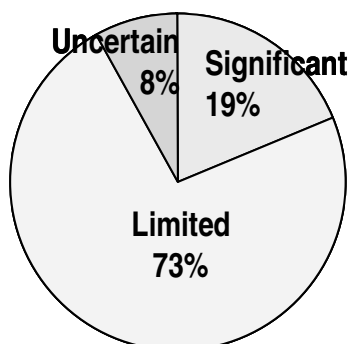
Findings include:

- 1) 63% of the private companies are currently conducting post-project activities, which covers 91% of the monitored projects.
- 2) 21% of the entities have reached a stage of practical application or commercialisation of R&D achievements.

Source: New Energy and Industrial Technology Development Organisation (NEDO) of Japan.

Figure 8.6. Results of detailed follow-up interviews in FY 2004

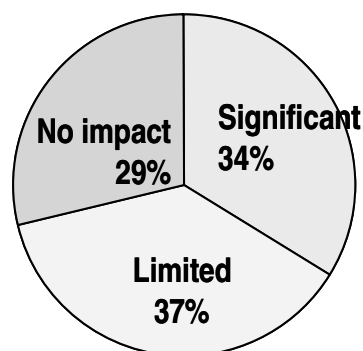
□ Significant □ Limited □ Uncertain



Contribution to job creation

(n=36)

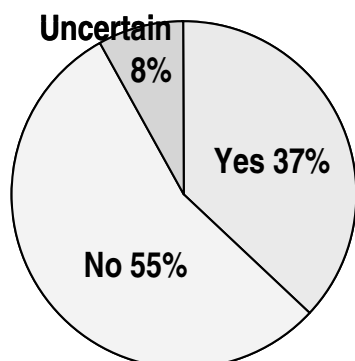
□ Significant □ Limited □ No Impact



Impact on academic field

(n=38)

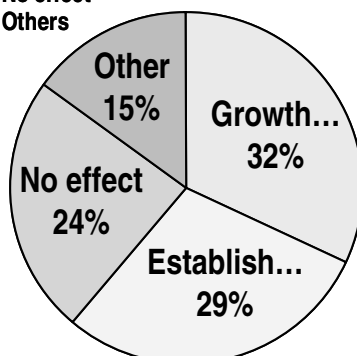
□ Yes □ No □ Uncertain



Contribution to establishment of a new enterprise

(n=38)

□ Growth of a concerned R&D department
□ Establish a related R&D project
□ No effect
□ Others



Effect on R&D policy of companies

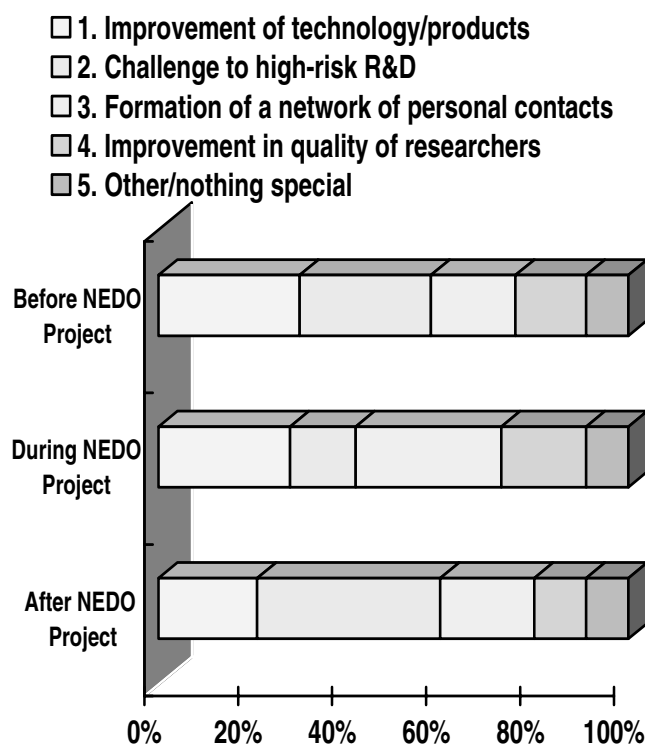
(n=41)

Source: New Energy and Industrial Technology Development Organisation (NEDO) of Japan.

- Over 90% of the monitored firms identified some effect on job creation after realising practical application or commercialisation of their R&D achievements; however, this effect was limited.
- Over 70% of the monitored firms acknowledged that the results obtained from NEDO's R&D project had some impact on the academic field. Moreover, 34% of the firms considered these effects to be significant.
- Up to 37% of the monitored firms established new enterprises such as new R&D departments, spin-off firms, joint ventures, etc., after realising practical application or commercialisation of their R&D achievements.
- Growth of the R&D department concerned was observed in 32% of the monitored firms and related R&D projects were launched in 29% of the monitored firms.

Responses to one particular question indicated that the expectations of the monitored firms regarding NEDO's project differed before and after the project. Prior to NEDO's project, there were high expectations regarding the improvement of the technology concerned and/or product performance and a challenge to high-risk R&D. During the project, it was recognised that NEDO's project was useful for improvement of the technology concerned and/or product performance and the establishment of a network of personal contacts. However, after the project, challenging high-risk R&D was recognised to be the most likely objective of NEDO's project (see Figure 8.7).

Figure 8.7. Expectations of participant firms regarding NEDO's project



Note: Responses 1 through 5 are depicted in graph from left to right.

Source: New Energy and Industrial Technology Development Organisation (NEDO) of Japan.

Simplified monitoring and several follow-up evaluations will be performed each year, and the results obtained from these evaluations will be analysed in order to improve NEDO's project management skills.

Observations from the survey investigation on national project management

Sakakibara *et al.* (2003) investigated the project management of the organisations participating in national projects (large-scale R&D projects financed by the government) in 2002 as part of the study on evaluation of national projects. The purpose of the investigation was to collect fundamental data regarding the extent of participation in a national project, the condition of evaluation, development of human networks among organisations, practical co-operation with external organisations, etc.

In this investigation, a “national project” implies a project wherein funds were provided by the various systems of the following two ministries and agencies. Projects conducted by ministries other than the following are not considered in this paper.

- The former Ministry of International Trade and Industry (now METI): *e.g.* large-scale industrial research and development system, new energy technology R&D system, next generation industry basic technology R&D system, etc.
- The former Science and Technology Agency (now MEXT): *e.g.* the special co-ordination funds for promoting science and technology, large-scale atomic energy R&D projects, space development programmes, etc.

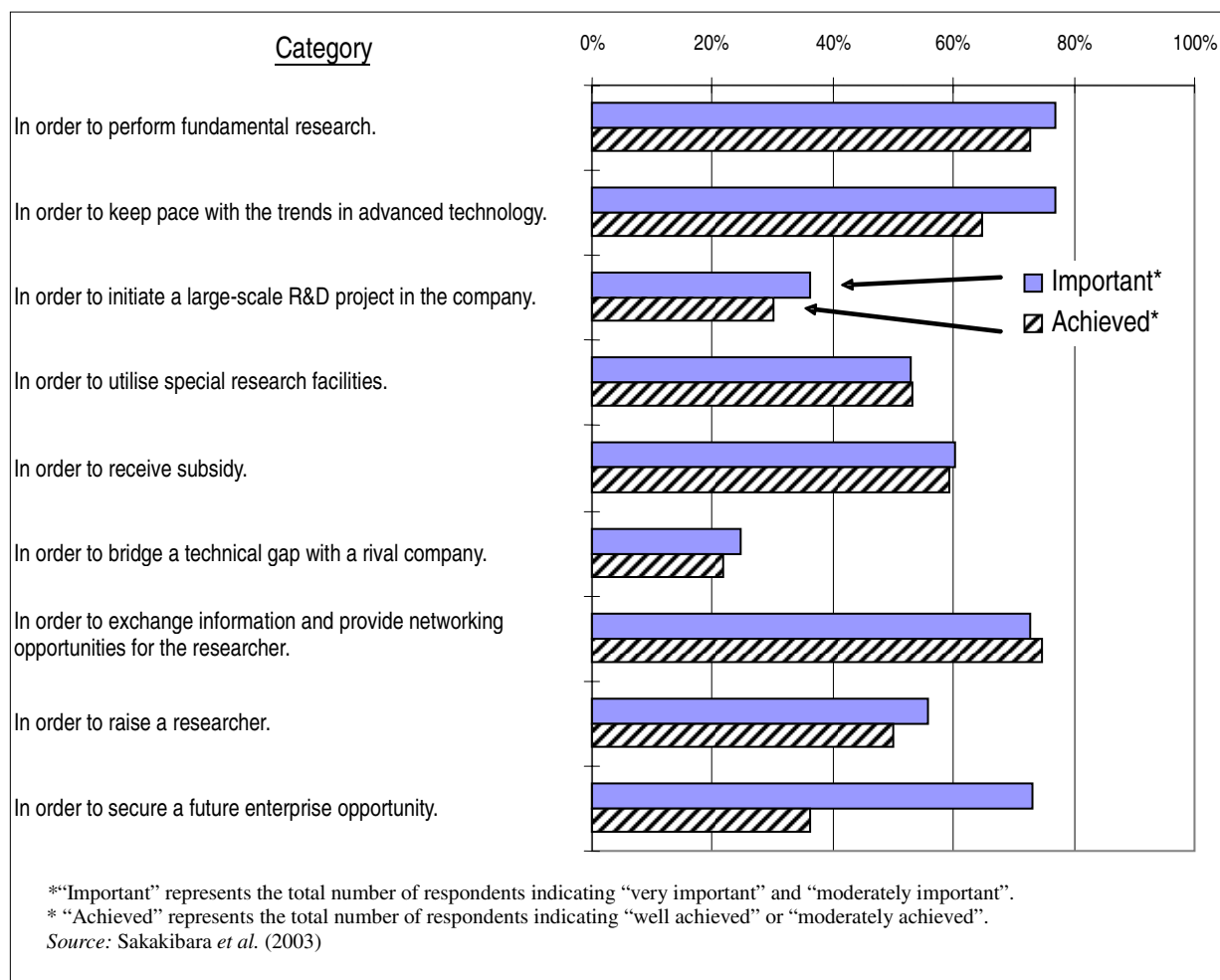
In May 2002, questionnaires were mailed to firms belonging to the manufacturing industry listed among the Tokyo Stock Exchange first section firms and the completed questionnaires were collected in July. The manager specialising in research and development in each firm (or equivalent) was asked to respond. The number of questionnaires dispatched was 1 924 (two or more questionnaires may be sent to the same firm), and 554 responses were received; the response rate was 28.8%. The number of cases considered for analysis, excluding duplicate and incomplete responses, was 509, including 212 (41.7%) national project participant firms and 297 (58.3%) non-participant firms. The following summary regarding the purpose of participation in a national project, the results obtained, and the analysis of the evaluation are based on the responses of only those firms that participated in the project.

The objective of participation in a national project

The objectives of project participation were classified into nine categories and listed in the questionnaire. Using a five-point Likert scale, respondents were asked to specify how important they considered each category and how many of the objectives listed were actually attained.

The results indicate that the objectives of “in order to perform fundamental research” and “in order to keep pace with the trends in advanced technology” were considered to be important (a total of 163 (76.9%) firms rated these objectives as “moderately important” or “very important,” which is the highest among all categories). In addition, 155 firms (73.1%) considered the objective “in order to secure a future enterprise opportunity” as important, while 154 firms considered the objective “in order to exchange information and provide networking opportunities for the researcher” as important.

Figure 8.8. Objectives of participation in a national project and the extent of attainment of these objectives



Regarding the extent to which these objectives were realised, the objectives of “in order to perform fundamental research”, “in order to keep pace with the trends in advanced technology”, and “in order to exchange information and provide networking opportunities for the researcher” were considered to be achieved with reasonable success. However, only 73 firms (36.3%) considered that the objective of “in order to secure a future enterprise opportunity” was “well achieved” or “moderately achieved” (see Figure 8.8).

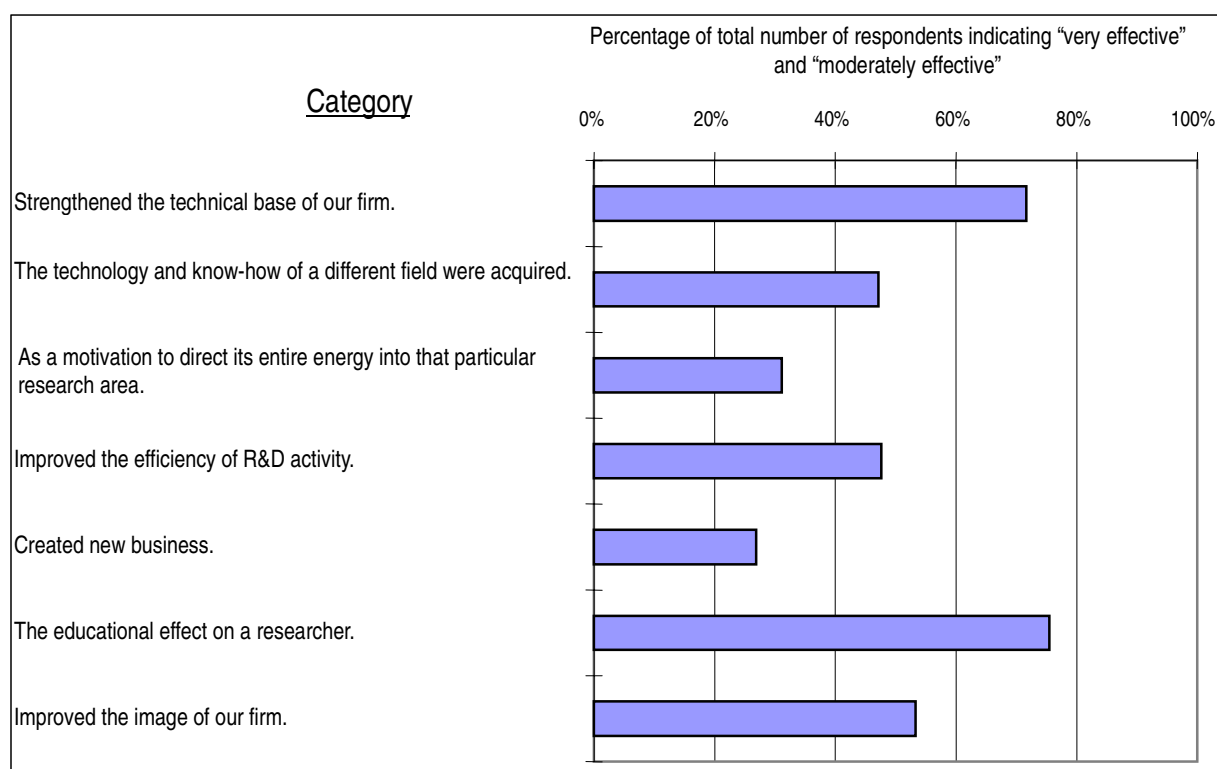
These results imply that with regard to fundamental research and human resource development aspects, national projects may well have the behavioural additionality effect, although their direct commercial effect is limited.

In addition, another question enquired whether a parallel project with an almost identical theme already existed in the participant firm. The results reveal that 73 firms (34.4%) had such a parallel project, while 134 (63.2%) did not. This result can be considered as a proof of the existence of input additionality of national projects.

The indirect effects of national projects

The anticipated indirect effects of national projects were classified into seven categories and listed in the questionnaire, and the respondents were questioned regarding the actual impact of each category. As many as 160 (75.5%) firms responded that “the educational effect on the researcher” was “very effective” or “moderately effective.” In addition, 152 (71.7%) firms responded that the effect “strengthened the technical base of our firm” was “effective”. A small number of firms also responded that “as a motivation to direct our entire energy into that particular research area” was “effective.” This result reveals the other aspect of the behavioural additionality effect that accompanies national projects (see Figure 8.9).

Figure 8.9. Indirect effects of national projects



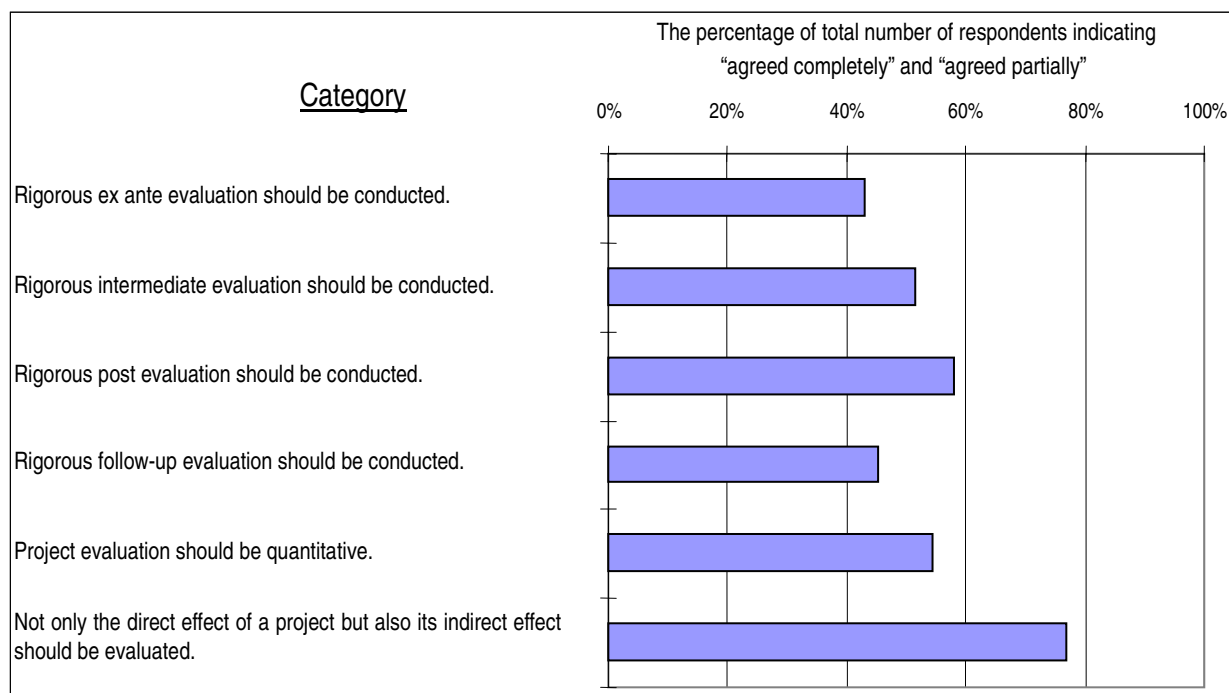
Source: Sakakibara *et al.* (2003)

Opinion on the focus of evaluation

The opinions frequently encountered in the evaluation of R&D projects were classified into six categories, and the respondents were questioned on the extent to which they agreed with each opinion. The maximum number of firms—as many as 163 (76.9%) — responded that they “agreed completely” or “agreed partially” with the opinion “not only the direct effect of a project but also its indirect effect should be evaluated”. This was followed by the opinion “project evaluation should be quantitative,” to which 115 firms (54.2%) “agreed completely” or “agreed partially” (Figure 8.10).

In conventional project evaluation, in many cases, whether the goal defined as a direct target (usually a technical one) was attained was based on the judgment of the respondent. However, it appears that the opinion that national R&D projects should be evaluated from the viewpoint of both direct and indirect effects is strong among the participant firms.

Figure 8.10. **Opinions on the focus of project evaluation**



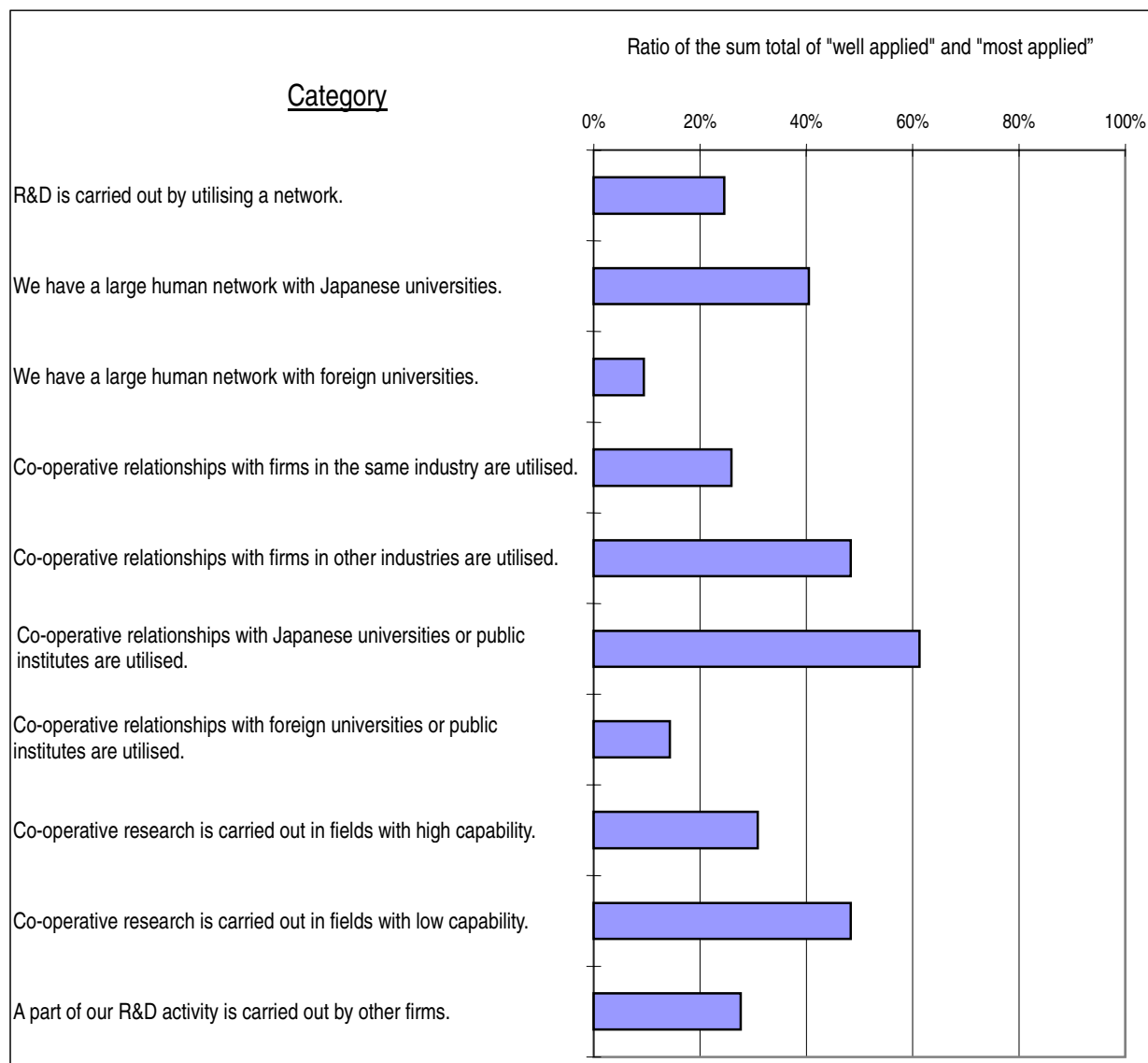
Source: Sakakibara *et al.* (2003)

Networking and co-operation with external organisations

All firms were asked to respond to the following questions, irrespective of whether they participated in national projects. The conditions of practical use of networking and co-operation with external organisations were classified into ten categories, and the respondents were asked whether each category was applicable to their firms. Consequently, 125 firms (24.6%) responded that the condition "R&D is carried out by utilising a network" was applicable to them, while 141 (27.7%) responded that the condition "a part of our R&D activity is carried out by other firms" was applicable in their case (Figure 8.11).

The outcome of networking and R&D co-operation was enquired about in the same manner. As the results, 331 (65.0%) and 243 (47.7%) firms responded that the outcomes "the educational effect on a researcher" and "the technology and know-how of a different field were acquired," respectively, were "effective".

Figure 8.11. Conditions of networking and co-operation



Source: Sakakibara *et al.* (2003)

The share of domestic public organisations as partners in R&D co-operation with firms was higher than that of foreign ones in the case of both joint research and human networks. With regard to co-operation with other firms, cross-industrial co-operation was observed to be more common than intra-industrial co-operation. In general, Japanese firms tend to prefer domestic universities and national institutes rather than other competitive firms. With regard to the technical field, co-operative research in fields with low capability exceeded co-operative research in fields with strong capability.

This investigation was not conducted for the purpose of clarifying the behavioural additionality effects on firms; it was performed at a time when the concept of behavioural additionality itself had not been recognised. Therefore, the question “if not,” which is frequently used for comparison, was not used, and interpretation with respect to additionality effects can only be restrictive. Nevertheless, it is an assumption that firms’ behaviours, such as challenge to high-risk fundamental research, human resource development, and networking and co-operation, were modified by government subsidy.

Future challenges and recommendations

The Japanese cabinet implemented the “National Guidelines on the Method of Evaluation for Governmental R&D” in 2001 and revised the guidelines in March 2005. These guidelines are applicable primarily to the R&D activities carried out at governmental institutes and universities; however, they are also applicable to the activities of government-financed private firms. The present version of these guidelines does not include any description or concept concerning behavioural additionality, although there are general descriptions referring to spin-off effects.

It is argued that it is inappropriate for government R&D to be evaluated through heavy use of input additionality indicators and short-term output additionality indicators because they induce attitudes that prefer low-risk short-range-oriented research agenda. Behavioural additionality indicators may well complement these shortcomings accompanying direct indices, although their definition and methodologies are still in the development phase. Therefore, it is important for the Japanese government to show full commitment to the development and dissemination of the concept of behavioural additionality and revise the National Guidelines to incorporate this concept at the earliest.

In these contexts, the following policy issues should be addressed in the future work of the Japanese government (Box 8.1):

Box 8.1. Recommended future policy work of Japanese government

- **Building behavioural additionality (BA) evaluation methodologies and customisation.** It is necessary to quickly build BA evaluation methodologies fitting to Japanese R&D circumstances. It is also necessary to harmonise the Japanese methodologies to international ones when the BA evaluation is added to the international innovation surveys.
- **Promoting BA evaluations.** There is a tendency to stress the importance of short-term results and evaluate only the output additionality in Japanese R&D project evaluations. In order to improve efficiency and effectiveness of Japanese R&D, it is necessary to evaluate input additionality, output additionality and behavioural additionality in good balance, and to actively introduce BA evaluations into the domestic R&D systems. More specifically, it is desirable 1) to require practicing BA evaluations for R&D of private companies funded by government in the “National Guidelines on the Method of Evaluation for Governmental R&D”, 2) to practice BA evaluations for R&D of private companies not funded by the government through the “Survey of Research and Development” by the Ministry of Internal Affairs and Communications.
- **Improvement and complementary combinations of policy tools to raise BA effects.** It is pointed out from the case studies that the BA effects in policy tools of governmental subsidies are high in terms of “challenge for high-risk and basic research”, “strengthening of technological infrastructures” and “development of human resources for research”, but neutral in “building research network with outside” and not so high in “strengthening market competitiveness” and “expansion of business”. For the point where the BA effect is not sufficient, it is necessary to investigate possible improvement of current governmental subsidies or complementary combinations of other policy tools such as tax incentives.

In order to accumulate data and advance analysis with respect to behavioural additionality aimed at accurate evaluation of projects and policies, the following issues should be addressed:

- Extraction of data from the viewpoint of behavioural additionality from existing survey data or case studies concerning evaluation.
- In the detailed follow-up monitoring that is carried out by NEDO, the categories considered in the investigation should be incorporated from the viewpoint of not only input/output additionality but also behavioural additionality.
- In addition to the evaluation of subsidies, evaluation of broader innovation policies such as R&D tax incentives, revised in 2003, and the recent revision of the patent law, etc., should adopt the behavioural additionality viewpoint.
- Incorporate the categories considered in the investigation from the viewpoint of behavioural additionality in the Innovation Survey of Japan, which is conducted in an internationally co-ordinated manner.
- Exchange information through active participation in the international research community of behavioural additionality in the OECD, etc.

The main difficulty in evaluating behavioural additionality is that it becomes desirable to investigate the R&D activities of firms that did not receive a subsidy in order to perform a controlled analysis of a negative scenario. It will probably be necessary to collect data using designated statistics such as the above-mentioned research and development survey in order to achieve this. Since re-examination of the research and development survey would need to keep pace with international science and technology statistics, work should be carried out in co-ordination with OECD and its various working parties.

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Chapter 9

BEHAVIOURAL ADDITIONALITY OF PUBLIC R&D FUNDING IN KOREA

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Abstract. This chapter summarises results of an empirical investigation into the relationship between public and private R&D funding. It considers the different effects that R&D performed in public research organisations and that government subsidies for business R&D might have on private R&D investment. It uses econometric techniques that employ a behavioural equation for private R&D investment and polynomial distributed lags to capture the dynamic effects of public R&D funding. The results show that public R&D funding has a significant and positive effect on levels of private R&D investment. The study also finds that the effect of government-performed R&D is greater than that of government subsidies. In the dynamic analysis, government-performed R&D was shown to have a more enduring effect, lasting up to 12 years with a peak in the ninth year, while hardly any evidence can be found of long-run behavioural effects of government subsidies.

Introduction

In a knowledge-based economy, science and technology-based innovation increasingly draws attention to long-run productivity and growth, with particular emphasis on the role of the private sector in national innovation systems. This is because the economic benefits of S&T development can be exploited only through the productive activities of private firms. Thus, when the government pursues policies to increase the innovation capability of the private sector, it is important to investigate whether and how public R&D funding stimulates private R&D investment.

Debates continue about whether or not public funding of R&D complements or crowds out (substitutes for) private R&D investment.¹ In Korea, empirical results are divided between these two camps. Kwon and Ko (2004) used firm-level data and a difference-in-difference (DID) model (as in Lach, 2000) to show that government R&D subsidies have a substitution effect on the R&D investment of the private firms. This study focused only on government subsidies for business R&D, however, not on government-performed R&D, which accounts for the major part of public R&D funding. Lee (2004) combined R&D data and financial data at the firm level to show that government subsidies have a complementary effect on private R&D. He estimated simple

1. According to the literature survey of David, Hall and Toole (2000), the relationship between public and private R&D turned out to be in most cases substitute at the firm level studies, and complementary at the aggregate level studies.

regression coefficients by adding more control variables. If a simple regression model is employed, however, endogeneity problems are unavoidable because greater amounts of funding would be directed to firms that make the greater R&D investments. To resolve this problem, Kwon and Ko (2004) employed a more elaborate model, but did not deal with long-run behaviour and dynamic effects of R&D investment.

Use of aggregate data can address some of the limitations of national analyses, but also produce conflicting results. Aggregate data mitigates the endogeneity problem to some degree and can capture spillover effects in exploring the relationship between the public and private R&D. Using aggregated data, Levy (1990) and Robson (2001) showed a complementary effect of public funding on private R&D. Guellec and Pottelsberghe (2003) also used aggregate data and broke down government R&D funding into that for universities and government research institutes (GRIs), civil R&D and defense R&D. They showed that government R&D has a substitution effect and that subsidies to business R&D have a complementary effect. With some limitations, they provide an analysis of the dynamic effects of policy variables. In their study, however, there is no flexibility in determining the number of lagged variables. (Guellec and Pottelsberghe, 2003).

This study presents an empirical investigation of the effects of government R&D and subsidies for business R&D on private R&D investment in Korea using aggregate data. Government R&D is defined as government funding of R&D performed by GRIs and universities, and subsidies are defined as R&D funds that firms receive from the public sector. In Korea, government R&D accounts for over 90% of total government R&D spending and subsidies less than 10%. These two types of funding can have different effects in stimulating business R&D, *i.e.* while government subsidies may have a direct effect of the level of a firm's R&D investment, government R&D could have indirect effects. Government R&D can create spillover effects (producing knowledge that firms can use and/or improving the R&D environment), but it can also increase the price of R&D resources. These effects may not be immediate, but may occur over time and exert a more subtle influence on the R&D decision making of firms.

This study is organised as follows. The following section discusses a theoretical framework for determining the optimal level of a firm's R&D investment, and policy measures through which the government may influence the business R&D. The next section establishes an empirical model for private R&D investment at the aggregate level, combining the investment function of optimal R&D and a partial adjustment model. This model enables analysis of the effects of policy variables in the long run and short term. Furthermore, polynomial distributed lags are incorporated into the model to investigate the dynamic effects of the government R&D and subsidies. The study then discusses the empirical findings.

Theoretical framework

The optimal R&D investment will be determined when the marginal cost of capital is equal to the marginal rate of return to R&D.² Mathematically, the marginal cost of capital, MCC, which reflects the opportunity costs of funds at a different level of R&D investment and the marginal rate of returns to R&D investment can be expressed, respectively, as:

$$MCC = h(R; X) \quad (0.1)$$

$$MRR = g(R; Z) \quad (0.2)$$

where R denotes firm's R&D investment; and X and Z shift factors. Equation 0.1 represents the determination of the marginal costs of funds for business R&D expenditure. Since the R&D investment of the firm is to compete with alternative investments, the opportunity cost of R&D will rise, assuming that R&D expenditures exhibit diminishing returns. Thus, the MCC curve will slope upward. On the other hand, following the assumption of diminishing returns to funds, the MRR will decrease as R&D expenditure rises. Diminishing returns occur because returns to R&D efforts — which is an increasing function of R&D expenditure — is diminishing, or because the firm is faced with increasing costs as the firm employs more R&D inputs, such as scientists, engineers and others.³ Thus, the MRR curve slopes downward. Therefore, the optimal R&D expenditure of the firm will be determined when the MRR curve meets the MCC curve. At this point, the firm's optimal R&D expenditure, R^* , is denoted as a function of X, Z , *i.e.*:

$$R^* = f(X, Z) \quad (0.3)$$

The firm's optimal R&D investment is influenced by market variables and policy variables. In the market, firm's R&D investment will be influenced by real rate of interest and income variable such as sales or profits. The real interest rate represents the opportunity costs of financing R&D funds over alternative investment opportunities. Therefore, if the real rate of interest rises, R&D investment of the firm will decrease. Private R&D investment is also influenced by the firm's sales. In general, the firm with a greater sales volume would make greater investment in R&D.

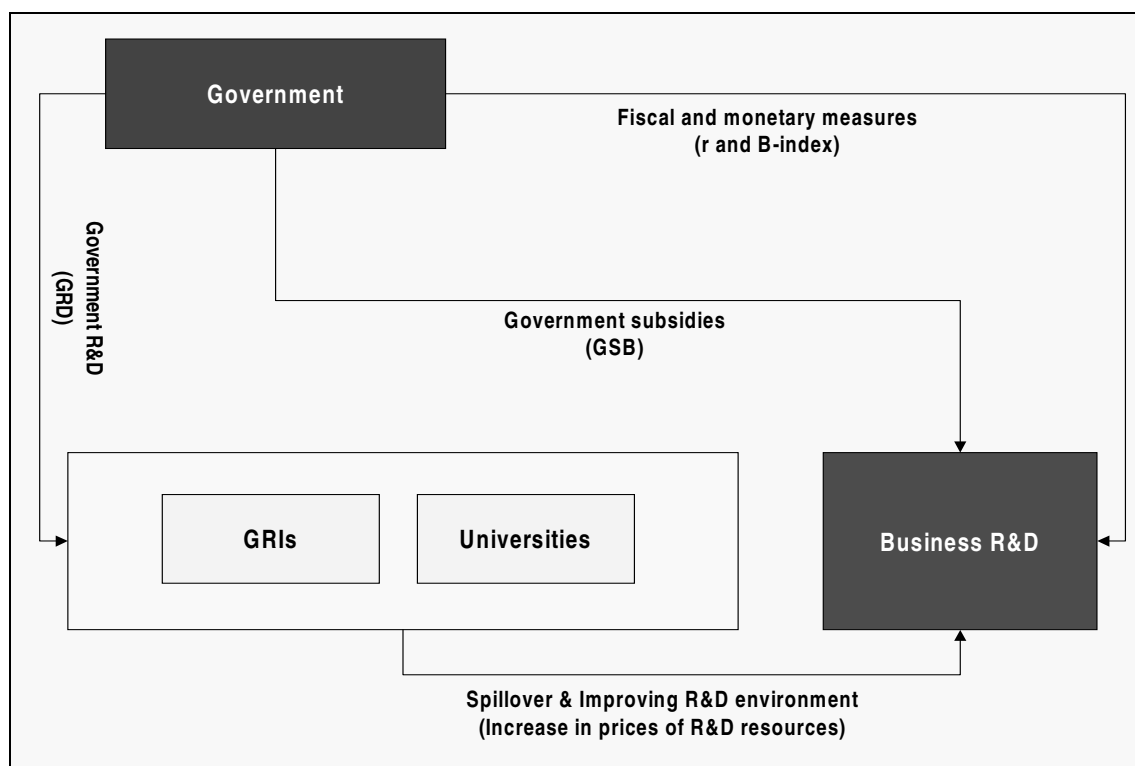
Public policy influences private R&D investment in various ways (see Figure 9.1). The government may perform R&D by providing funding to GRIs and universities, focusing on pre-competition technologies, such as through basic research, target-oriented basic research, and development of platform technology, etc. In this case, government R&D will not only have spillover effects by the results of R&D, but will also have the effect of improving the R&D environment in the private sector. Such effects will in time lead to an increase in private R&D investment, as the firm perceives greater business opportunities from R&D. It is noted in this case that government R&D will have a dynamic effect over a certain period. On the contrary, by increasing R&D expenditure and performing R&D, the public sector competes for R&D resources with the private

2. This result is shown in Robson (2001) and Howe and McFetridge (1976).

3. For more discussion, see Robson (2001).

sector, which can lead to a price increase of R&D resources. In this scenario, private R&D investment would decrease as government R&D increases. Alternatively, firms may perceive that because government R&D being undertaken, they should postpone R&D investments and wait until the results of government R&D are released. Therefore, government R&D has an ambiguous effect on private R&D investment. If it has both positive and negative effects, then the net effect will depend on the empirical evidence.

Figure 9.1. Policy measures on business R&D expenditures



Another policy measure for stimulating business R&D investments is to subsidise the costs of a firm's R&D activity. In this scenario the subsidy is defined as funds that the firm receives from government sources, *i.e.* tax money in a broad sense. Thus, the subsidy will be implemented by direct injection of funds from the government to the firm.⁴ This may have the effect of decreasing the firm's R&D costs so that it can increase its R&D investment. However, if the firm already knows that it will receive the subsidy, it may plan to invest less. Therefore, the effect of the subsidy on private R&D investment is ambiguous. In addition, since government subsidies are not provided randomly, it is likely that the government will provide greater subsidies to firms that makes greater R&D investments and undertake R&D on a larger scale. This causes an endogeneity problem, and some studies have dealt such scenarios (Lach, 2000; Kwon and Ko, 2004).

Tax incentives for R&D represent another way of subsidising business R&D. The effect of tax incentives is horizontal, so that larger firms that make greater investments in R&D will reap greater benefits. In measuring R&D tax incentives, Warda (1996) developed

4. Government subsidies here would take various forms: grants, contracts, loans, etc.

an index (the B-index), which is an analogue to the effective tax rate. The higher the B-index, the less generous the R&D tax incentives provided by the government.

The empirical model

From the preceding discussion, the optimal private R&D investment at the aggregate level can be expressed as a function of real interest rate, GDP and policy variables, *i.e.*:

$$RPV_t^* = f(r_t, y_t, GRD_t, GSB_t, BDX_{t-1}) \quad (0.4)$$

$$= \lambda_0 + \lambda_1 r_t + \lambda_2 y_t + \lambda_3 GRD_t + \lambda_4 GSB_t + \lambda_5 BDX_{t-1} + \varepsilon_t$$

where RPV_t^* denotes the optimal private R&D investment; r_t real rate of interest; y_t GDP; GRD_t government R&D; GSB_t government subsidy; BDX_{t-1} B-index at the t-1 period; λ_i parameter; and ε_t the statistical disturbance. In Equation 0.4, the parameter, λ_i , represents the long-run relationship of the i -th independent variable with the RPV_t^* . The optimal level of the private R&D investment is then related to the observed private R&D investment as follows:

$$RPV_t = RPV_{t-1} + \theta(RPV_t^* - RPV_{t-1}) \quad (0.5)$$

where RPV_t denotes observed private R&D investment, and θ the speed of adjustment. In Eq.(0.5), if $\theta=1$, then the observed and the optimal level of investment are equal. Combining Eq.(0.4) and (0.5) leads to

$$RPV_t = \beta_0 + \beta_1 r_t + \beta_2 y_t + \beta_3 RPV_{t-1} + \beta_4 GRD_t + \beta_5 GSB_t + \beta_6 BDX_{t-1} + \varepsilon_t \quad (0.6)$$

where $\beta_i = \lambda_i \theta$ and $\theta = 1 - \beta_3$. Since coefficients, β_i , in Eq.(0.6) represents the short-run relationship, the long-run effect of independent variables can be computed by $\beta_i / (1 - \beta_3)$. After estimating Equation 0.6, an analysis of the long-run and short-run effect of government R&D and subsidies on the private R&D investment is possible at the aggregate level.

In estimating Equation 0.6, is expected that $\beta_1 \leq 0$, $\beta_2 \geq 0$, $\beta_3 \geq 0$ or ≤ 0 , $\beta_4 \geq 0$ or ≤ 0 , $\beta_5 \geq 0$ or ≤ 0 $\beta_6 \leq 0$. That is, the private R&D investment will be negatively related to the real interest rate, positively to the income variable, and negatively to the B-index. The B-index is included at the t-1 period, because it will take time for firms to respond to additional tax incentives. On the one hand, the signs of GRD_t and GSB_t depend on the empirical results. If they are positive, then government R&D and subsidies both have positive effects on the private R&D investment, and vice versa. On the other hand, to estimate for once and for all the effect, and to investigate the dynamic effects of government R&D and subsidies, a model of polynomial distributed lags is used:

$$RPV_t = \alpha_0 + \alpha_1 \sum_{i=0}^m \omega_i GRD_{t-i} + \varepsilon_t \quad (0.7)$$

$$RPV_t = \alpha_0 + \alpha_1 \sum_{j=0}^n \delta_j GSB_{t-j} + \varepsilon_t \quad (0.8)$$

where ω_i and δ_j represent a weight, upon which various assumptions are possible using a polynomial.⁵ In these dynamic equations, we do not include other control variables, but focus on the dynamic behaviour of the independent variables of private R&D investment. It is expected that the effects of the government R&D and subsidies would fade out over time, without regard for the type of restriction imposed on their dynamic behaviour.

Estimation results

The aggregate data was used for the estimation. The statistical data for R&D are available in the *Report on the Survey of Research and Development in Science and Technology* of the Korean Ministry of Science and Technology (MOST). Other statistical data are mostly available on the Web sites of the Bank of Korea and the National Statistical Office.

In the MOST report on R&D data, the flows of R&D funds among industry, universities and government is captured. The major funding bodies are the government and private firms, while universities are primarily R&D performers.⁶ In this analysis, funds provided by the government to the universities and GRIs⁷ are used as the measure of government R&D, and funds that private firms received from the government are used as the measure the government subsidy. The real rate of interest is obtained by subtracting the inflation rate from the nominal yield on corporate bonds. Finally, the B-index borrowed from Sohn (2002) is used.⁸ Table 9.1 exhibits the summary statistics of the data.

The estimation of Equation 0.6 uses the generalised method of moments (GMM), because the OLS results were not satisfied. If one assumes that $E(\varepsilon\varepsilon') = \Omega$ and $E(Z'\varepsilon) = 0$, for the estimable equation $y = X\beta + \varepsilon$, where Z denotes a vector of the instrument variables, then the estimate of GMM will be $\hat{\beta} = (X'ZWZ'X)^{-1}X'ZWZ'y$, where W represents a weight matrix.

5. See Almon (1968).

6. The foreign sources were disregarded in the flows, because it accounts for a trivial portion, less than 0.1% of the gross R&D investment.

7. GRIs here also include national and public test research institutes.

8. Sohn (2002) related B-index to the business R&D expenditures, and his result shows positive relationship between them.

Table 9.1. **Summary statistics**

	<i>RPV</i>	<i>r</i>	<i>y</i>	<i>GRD</i>	<i>GSB</i>	<i>BDX</i>
Mean	4817.0	8.285	310200.0	1418.8	233.7	0.774
Median	4316.3	8.250	303333.0	962.0	110.8	0.788
Maximum	10619.5	12.113	524689.0	3269.9	901.1	0.826
Minimum	487.5	5.258	131159.0	518.3	2.6	0.702
S.D.	3057.7	1.859	122675.4	854.1	272.2	0.036
Obs.	21	21	21	21	21	19

1. *RPV* denotes firm's own R&D expenditure; *r* = real rates of interest; *y* = GDP; *GRD* = government R&D; *GSB* = government subsidy; *BDX* = B-index.
2. *RPV*, *y*, *GRD*, and *GSB* are in billions of won.
3. S.D. denotes standard deviation; Obs. The number of observations
4. Sample period is over 1982–2002.
5. B-index is used from Sohn (2002); the sample period is over 1982–2000.

Table 9.2 illustrates the estimation results. Different specifications were employed and estimated to assess robustness and the relevance of different variables. For all estimations, variables were included of real interest rate, GDP and dynamic term of RPV_{t-1} , and others in an alternate way. Estimated coefficients are significant, but coefficients of r_t in column 6 and y_t in column 3 are not. The private R&D investment is negatively related to the real interest rates, and positively to GDP. It is also positively related to the dynamic term of RPV_{t-1} . It is noted that the coefficient of RPV_{t-1} is less than one.

From columns 1 through 6, it can be seen that all coefficients of GRD_t , GSB_t and BDX_{t-1} are significant. It is also shown that the policy variables of the government R&D and subsidy have a positive effect on the private R&D investment. The coefficient of the B-index turns out to be negative, implying that tax incentive has a positive effect and hence promote the private R&D investment.

The long run effect can be shown by $[\hat{\beta}_i / (1 - \hat{\theta})]$, where $\hat{\theta}$ is the estimate of the speed of adjustment and is related to the estimated coefficient of RPV_{t-1} , that is, $\hat{\theta} = 1 - \hat{\beta}_3$. Since $\hat{\theta}$ is less than one, the effects of independent variables are greater in the long run than in the short run. This is an important aspect of behaviour of the private R&D investment.

Using estimation results, once can compute the elasticity of each variable with respect to mean value. As shown in Table 9.3, the long-run elasticity is greater than the short-run elasticity. On average, the long-run elasticity of GDP is greater than one, which implies that the private R&D investment responses sensitively to the change in GDP. All other elasticities are less than one. Among the elasticities of the policy variables, GRD_t , GSB_t and BDX_{t-1} , the elasticity of BDX_{t-1} is largest, and that of GSB_t smallest, in both the short run and the long run. It is noted that the elasticity of real interest rate is larger than that of government subsidies. This means that monetary measures might be more effective in stimulating private R&D investment than subsidies for private R&D.

Table 9.2. Estimation results: effect of GRD and GSB on private R&D investment

	Dependent variable : RPV_t					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Constant</i>	-1129.61 ^a (-5.969)	-1104.39 ^a (-5.094)	872.71 ^d (1.325)	-893.77 ^a (-3.748)	432.74 ^d (1.022)	243.49 ^d (0.379)
r_t	-74.886 ^a (-3.052)	-31.960 ^b (-2.658)	-23.705 ^b (-2.690)	-45.945 ^c (-1.995)	-33.542 ^b (-2.262)	-17.695 ^d (-1.502)
y_t	0.015 ^a (9.555)	0.014 ^b (11.29)	0.003 ^d (1.013)	0.014 ^a (8.876)	0.011 ^a (12.09)	0.015 ^a (8.955)
RPV_{t-1}	0.304 ^a (3.528)	0.306 ^a (8.284)	0.909 ^a (6.656)	0.224 ^a (3.017)	0.401 ^a (8.757)	0.125 ^c (1.887)
GRD_t	0.439 ^a (4.097)			0.243 ^b (2.189)	0.942 ^a (8.766)	
GSB_t		1.841 ^a (5.770)		2.066 ^a (5.726)		2.926 ^a (10.18)
BDX_{t-1}			-1022.56 ^b (-2.722)		-2207.72 ^a (-3.789)	-1835.15 ^b (-2.647)
R^2	0.983	0.984	0.952	0.983	0.964	0.973
<i>SER</i>	442.463	434.486	696.279	458.412	620.214	532.950
<i>D.W.</i>	1.866	1.680	2.024	1.510	1.297	1.073
<i>J-statistic</i>	0.264	0.226	0.283	0.462	0.281	0.131
<i>Sample period</i>	1982~02	1982~02	1982~00	1982~02	1982~00	1982~00

1. All equations were estimated by GMM.

2. The numbers in the parentheses are t-values.

3. SER denotes standard error of regression; D.W. Durbin-Watson statistics.

4. a, b and c are significant respectively at 1%, 5% and 10% levels; d implies insignificance at 10% level.

Table 9.3. Long-run and short-run elasticities

		Estimated equations						Average (1)~(6)
		(1)	(2)	(3)	(4)	(5)	(6)	
Long run	r_t	-0.185	-0.079	-0.448	-0.102	-0.096	-	-0.182
	y_t	1.388	1.299	-	1.162	1.183	0.978	1.202
	GRD_t	0.186	-	-	0.092	0.463	-	0.247
	GSB_t	-	0.129	-	0.129	-	0.144	0.134
	BDX_{t-1}	-	-	-1.806	-	-0.592	-0.299	-0.899
Short run	r_t	-0.129	-0.055	-0.041	-0.079	-0.058	-	-0.072
	y_t	0.966	0.902	-	0.902	0.708	0.966	0.889
	GRD_t	0.129	-	-	0.072	0.277	-	0.159
	GSB_t	-	0.089	-	0.100	-	0.142	0.111
	BDX_{t-1}	-	-	-0.164	-	-0.355	-0.295	-0.271

Notes: 1. Insignificant coefficients are excluded.
2. The elasticities are computed on the mean values of the variables.

From the estimation results of the behavioural equation, the long-run policy seems to be more important regarding the private R&D investment. Thus, it will be interesting to investigate the dynamic behaviour of the private R&D investment in response to the policy measures. In so doing, the polynomial distributed lags are employed as shown in Equations 0.7 and 0.8. The estimation results are reported in Table 9.3.

Equations 0.7 and 0.8 are estimated by OLS. The estimation results show high R^2 and strong significance. In estimation, the number of lags was determined by the Schwarz information criterion.⁹ First, it is shown that the effect of the government R&D continues for up to 12 years. Meanwhile the effect of the government subsidies dies off quickly. The empirical results show that the effect of the government R&D on private R&D investment is negative over the first four years and rises with a peak at the ninth year after the policy was implemented. Meanwhile, government subsidies have a strong effect the first year, but it declines rapidly and becomes negative from the third year on, although coefficients of all lagged variables of GSB_t are insignificant. This is illustrated in Table 9.4 and Figure 9.2. Such a result is compared with Mansfield (1992), in which it took 15 years at most—and eight years on average—for academic research to be commercialised.¹⁰ The overall effects of government R&D and subsidies in the model are 14.717 and 10.258, respectively.

9. In contrast to Guellec and Pottelsberghe (2003), the number of the lagged variables was determined using the Schwarz criterion.

10. See Mansfield (1992).

Table 9.4. Dynamic effects of GRD and GSB on private R&D investment

	Independent variable: GRD_t		Independent variable: GSB_t	
	Coefficients	t-values	Coefficients	t-values
Constant	-2906.71 ^a	-3.109	2429.461 ^a	6.388
Lagged variables				
$t-0$	-0.666 ^a	-3.219	8.209 ^b	2.275
$t-1$	-0.895 ^b	-2.996	3.282 ^d	0.874
$t-2$	-0.771 ^b	-2.599	-0.959 ^d	-0.309
$t-3$	-0.377 ^d	-1.701	-0.274 ^d	-0.040
$t-4$	0.202 ^c	2.058	-	-
$t-5$	0.884 ^a	10.83	-	-
$t-6$	1.585 ^a	6.460	-	-
$t-7$	2.221 ^a	5.480	-	-
$t-8$	2.709 ^a	5.059	-	-
$t-9$	2.965 ^a	4.825	-	-
$t-10$	2.905 ^a	4.677	-	-
$t-11$	2.447 ^a	4.575	-	-
$t-12$	1.507 ^a	4.500	-	-
Sum	14.717 ^a	6.460	10.258 ^a	3.155
R^2	0.949		0.844	
SER	599.334		1310.388	
Schwarz criterion	15.948		17.563	
D.W.	1.834		0.423	
F-statistic	112.731		30.632	
Sample period	1988-02		1982-02	

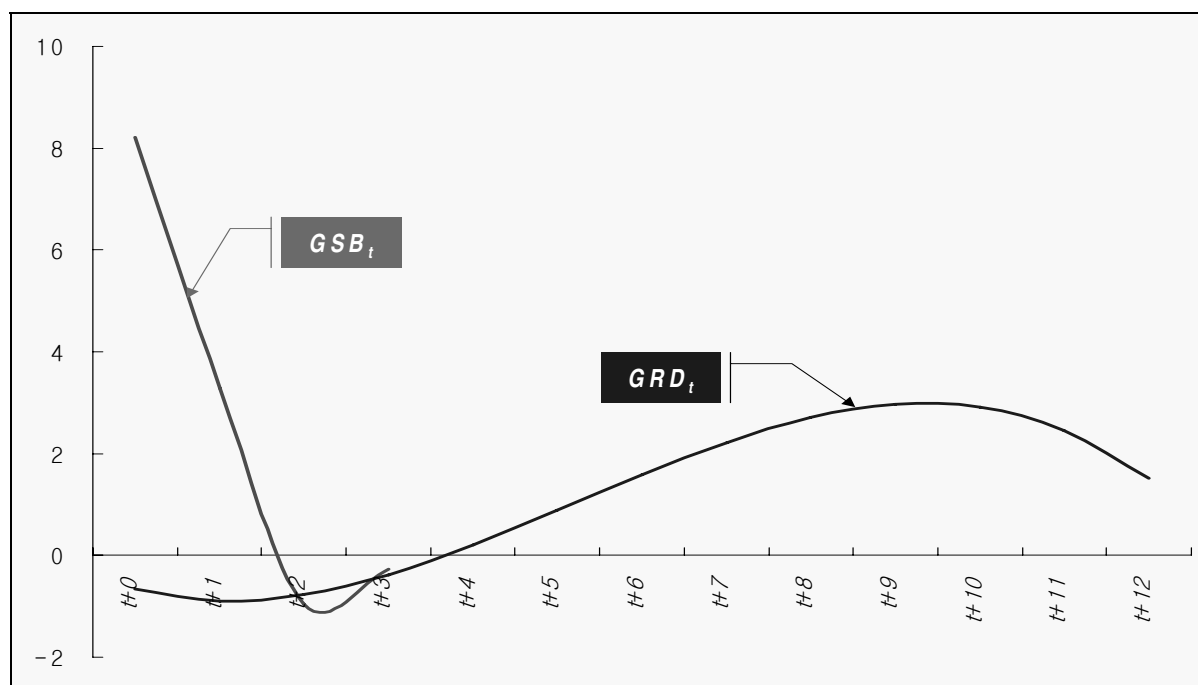
1. All equations were estimated by OLS.

2. The numbers in the parentheses are t-values.

3. SER denotes standard error of regression; D.W. Durbin-Watson statistics.

4. a, b and c are significant respectively at 1%, 5% and 10% levels; d implies insignificance at 10% level.

Figure 9.2. Dynamic effect of GRD and GSB over time



Concluding remarks

This empirical investigation of the relationship between public and private R&D considers that government R&D and subsidies might have different effects on private R&D investment. For the empirical model, a function is derived of the optimal private R&D investment at the aggregate level, whose determinants are the market and policy variables, such as real interest rate, GDP, government R&D, the government subsidy and the B-index. Combining this with the partial adjustment model, the behavioural equation was derived for the private R&D investment. On the other hand, to make an investigation of the dynamic behaviour of the government R&D and subsidy, polynomial distributed lags were employed. Aggregated data was used to estimate of both behavioural and dynamic equations.

From the empirical evidence of the behavioural equation, it is shown that both government R&D and subsidies to business R&D have a positive effect on private R&D investment. That is, if the government increases R&D funds to universities and GRIs and/or subsidies business R&D will increase. Thus, it is shown that the public R&D funding does not crowd out, but rather promotes private R&D activities. Based on the computed elasticities, the effects of government R&D and subsidies appear to be greater in the long run than in the short term. The elasticity of GDP was positive and greater than one in the long run, which implies that private R&D investment is a pro-cyclical activity, increasing when GDP grows. Out of the policy variables, the B-index has the largest effect, and the effect of the government R&D is greater than that of the government subsidy. The effect of changes in real interest rates is also significant and is greater than that of the government subsidy.

On the other hand, empirical results of the dynamic model show that the effect of government R&D continues for up to 12 years; its effect is negative for the first four years and reaches the highest point at the ninth year, from which point it then decreases. It seems that the government R&D crowds out private R&D at the beginning periods and thereafter promotes the private R&D investment. Overall, it has a positive effect. Meanwhile, the effect of the government subsidy lasts up to four years, but the coefficients of the lagged variables are not significant. The overall effect of government R&D appears greater than that of a subsidy.

In summary, public R&D *via* government R&D activities and subsidies to business R&D significantly and effectively influence the private R&D investment in the same direction. The effects are greater in the long-term than in the short-term, and the effect of government R&D is greater than that of subsidies. In particular, effect of government R&D, which influences the firm through spillovers and improvement of the R&D environment, etc., is important and long-lasting. Government subsidies, in contrast, seem to have little effect on the long-term behaviour of business R&D.

Because of the small sample size, the results of this investigation must be interpreted with care.¹¹ The endogeneity problem related to government subsidies also remains unsolved. These limitations and problems are left for future study.

11. Due to the small sample size, one cannot avoid some limitations particularly in consideration of econometric studies, such as existence of unit roots, cointegration, employment of the error correction model, the degree of freedom of the polynomial distributed lags, and others.

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Chapter 10

BEHAVIOURAL ADDITIONALITY OF INNOVATION NORWAY'S FINANCIAL SUPPORT PROGRAMMES

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Abstract. The Nordland Research Institute carries out client surveys among companies that have received approval for loans or grants from the major business support agency in Norway, Innovation Norway (IN). The client surveys are made up of a preliminary study, carried out one year after approval for financing, and a follow-up study 3-4 years later. This chapter presents the main findings of the follow-up study that was conducted among the companies receiving funding from IN in 2000. The study focuses on the results achieved, including how IN contributes to the realisation of the projects and how IN's involvement affects important objectives and processes of change and development in the companies. The latter relates to a number of different aspects. First, how do the projects contribute to competence enhancement, innovation and collaboration with others for the businesses? Second, do the projects lead to changes in the internal characteristics of the companies, *i.e.* their resources, competitive strategies and entrepreneurial orientation? Third, what kind of factors explain variations in business performance? It is found in particular that the firms' entrepreneurial orientation has a positive, significant effect in this regard.

Introduction

Background

The Nordland Research Institute carries out client surveys of companies which have received approval for loans or grants from Innovation Norway (formerly the Norwegian Industrial and Regional Development Fund), on behalf of the Norwegian Ministry of Trade and Industry, the Ministry of Local Government and Regional Development, the Ministry of Fisheries, the Ministry of Agriculture and Food, and Innovation Norway. These client surveys, which have been carried out since 1995, represent a systematic acquisition of information and an analysis of how Innovation Norway's (IN) financial and professional involvement affects the companies' financial and strategic development. The client surveys are made up of a preliminary study, carried out one year after approval for financing has been granted, followed by a follow-up study 3-4 years later. This report presents the main findings from a follow-up study of the participants in the preliminary study in 2001 (the 2000 group)¹.

1. See Madsen and Brastad (2005).

Objectives of the study

This follow-up study focuses on clarifying the effects of Innovation Norway (IN) support experienced by the companies which received funding approval in 2000, as expressed in terms of the results achieved. Table 10.1 shows the principal areas focused upon in the study. This overview also indicates a number of important objectives which among other factors form the basis for determining whether IN's assistance satisfies the objectives of the organisation.

Table 10.1. **Objectives and indicators**

Problem area	Objective	Type of measurement/indicator
How does IN contribute to the realisation of projects?	Counteract market imperfections	• Financing of projects • Additionality at outset • Project realisation in retrospect
How does IN's involvement affect important objectives and processes of change in a company?	Promote companies' profitability	• The importance of the project for profitability and survival • The importance of the project for cost reductions and revenue increases • Whether the company has achieved satisfactory performance
	Contribute to increased employment	• Jobs created • Jobs secured
	Contribute to enhanced competence and increased innovation	• Did the company experience enhanced competence? • The contribution of the project to innovation
	Contribute to increased competitiveness	• The importance of the project for development in various markets • Changes in the characteristics of the companies • IN's influence on the entrepreneurial orientation of the companies • IN's influence on the company's performance

Methodology

The analysis is based on interviews carried out from January to March 2004. The 1 209 companies which responded to the preliminary study were used as the starting point for the current follow-up study. Of these, 807 companies (67% of the selection) responded. 623 (52 percentage points) of these were actively operating while 15 percentage points (184 companies) had been closed down or declared bankrupt. Thirty-three percent of the companies declined to respond or were not available for contact. Relative to the sample involved in the preliminary study (2 261 companies), a response rate of 36% was achieved. The number of companies which responded at the various stages of the study is shown in Table 10.2.

Table 10.2. Original selection and number of responses to the preliminary and follow-up studies

Original selection	Responded to preliminary study	Did not respond to follow-up study	Closed down/bankrupt	In active operation
2261	1209	402	184	623
100%	53%	18%	8%	28%
	100%	33%	15%	52%

The follow-up study comprises ten types of financial support schemes²: secured loans, national venture capital loans, regional venture capital loans, national development grants, regional development grants, start-up grants for entrepreneurs, public and industrial research and development contracts (OFU/IFU), basic financing for fisheries operators, agricultural loans and rural development funds. IN's average project allocation and share of project financing for each of the support schemes are revealed in Table 10.3. A closer description of the objectives for each type of financial scheme is shown in Annex 10.1.

Table 10.3. Support scheme, IN's share of financing and average project allocation

Support scheme	IN's share of financing	IN's average project allocation (EUR)*	N
Secured loan	48 %	888 148	24
National venture capital loan	26 %	106 913	21
Regional venture capital loan	29 %	142 345	62
National development grant	25 %	45 802	24
Regional development grant	33 %	36 420	108
Start-up grant	39 %	9 630	118
OFU/IFU	31 %	127 407	43
Basic financing for fisheries	55 %	406 543	34
Agricultural loan	49 %	40 494	72
Rural development funds	38 %	11 728	117
Total	38 %	99 630	623

* 1 EUR = 8.10 NOK.

The analyses carried out indicate that the data material acquired is reasonably representative, based on the underlying dimensions of financial support composition, company size and regional policy support area. Although the data material is reasonably representative, there are other factors which affect the interpretation of the results and call for a degree of caution. These can be: general uncertainty surrounding relationships and effects, weaknesses of self-reported performance measures and possible sampling bias. Another possible source for bias is that participation in the client survey is voluntary. To obtain results giving the most reliable picture of the organisation, it is possible that this should be changed. It would be an advantage if the companies were obliged to provide information

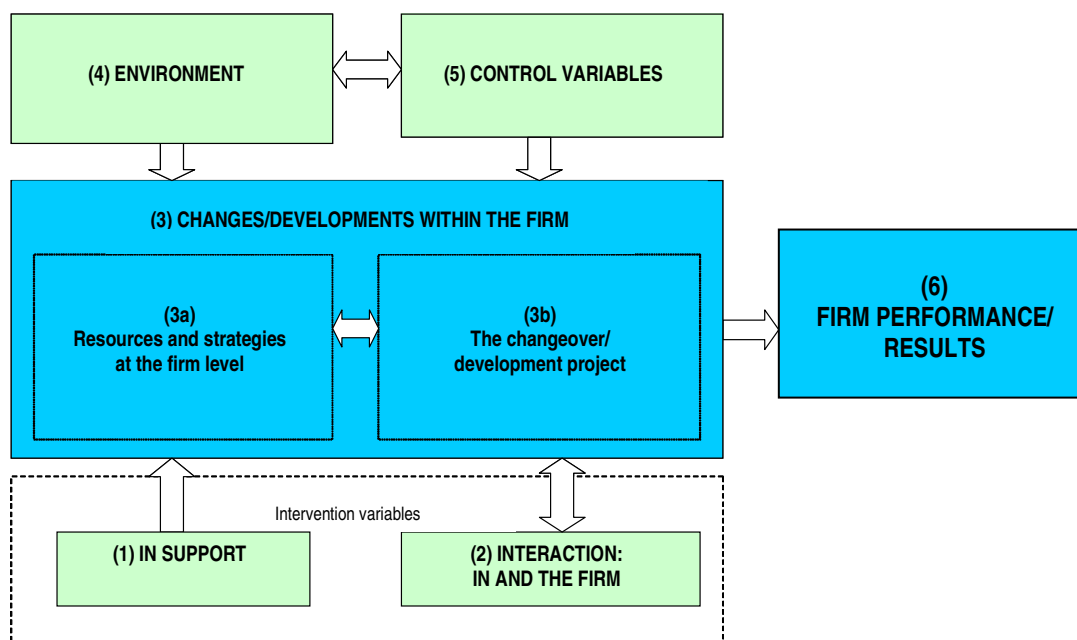
2. IN's various programmes are not all taken into consideration in this study. These programmes constitute a significant part of IN's involvement in competence development. The follow-up study will therefore not provide a comprehensive picture of IN's work on competence development.

for use in evaluations, in other words, if this became a requirement for receiving support. The problems in the data material described above could thereby be avoided to a larger degree, which would enhance the validity of the study.

Model of analysis

The starting point for the analysis is a model of the possible factors which can affect the companies. The follow-up study focuses especially on the effect or interaction which has taken place between IN and its funding, and the companies (1 and 2 in the model of analysis, see Figure 10.1), a review of the company's development (3), internal resources and strategic conditions (3a), the financed project (3b) and an evaluation of the company's financial performance (6). In addition, internal control variables connected with the development and history of the company are included in the model (5), as well as the company's perception of its environment (4). Factors connected with the environments, such as the development of economic conditions, trade and industry policy and similar *external* conditions are however not considered in this study. The main content of the model of analysis is shown in Figure 10.1.

Figure 10.1. Model of analysis



How does IN contribute to the realisation of projects?

The importance of the IN financing for the realisation of the project

The results show that IN has succeeded in contributing to a reduction in imperfections in the capital markets. Without IN financing, 53% of the participating companies would not have been able to realise the projects for which they received funding approval in 2000. Twenty-five percent state that they would have realised the projects even without public financing, while 16% would have realised the projects on a reduced scale or at a later time. Only 4% of the companies would not have realised their projects. Compared with the results for additionality in the preliminary study, the proportion of companies for which IN has had crucial importance for the realisation of projects has increased by 25%. The results are at approximately the same level as for the previous year.

Successful and misjudged projects considered in retrospect

The projects that have been approved for IN funding are to a large extent considered successful by the companies. Considered retrospectively, 78% of the companies state that their projects were successful, 16% consider them partially successful and 4% report failed projects. However, IN does not have complete information regarding the companies or projects at the time funding is approved. As a result, misjudgements (unsuccessful projects, projects with low additionality, companies going out of business or terminated projects) may happen. These misjudgements represent 22% of the original selection of projects. This is at the same level as for the 1998 group, but slightly higher than last year.

Financing of projects

Project financing is dominated by three sources: equity, IN funding and bank loans. On average, 40% of the project financing is by equity, 38% by IN funding and 16% by bank loans. These figures indicate that IN's contributions are important to the companies, which is further borne out by the fact that 14% of the companies have received additional financing from the organisation.

How does IN's involvement affect important objectives and processes of change in the companies?

The importance of the projects for the companies' financial development

Based on an overall assessment, the projects financed by IN are of considerable importance for the companies' *survival* and *profitability* development. This is borne out by the fact that 71% of the companies state that the project has considerable importance for their survival today, as well as the fact that 67% of them emphasise that the project is important for the development of their profitability. The projects also have a certain importance for the companies' *market development*, although the importance is significantly lower in this field than with regard to survival and profitability development. In the regional and national markets, approximately one-third of the companies experienced increased sales from 2000 to 2003 as a result of the IN-supported projects, while on the international market, this was the case for approximately one-sixth of the companies. Practically all the remaining companies state that sales have remained unchanged in the three markets.

In general, the projects which have received IN funding involve only parts of the companies' business activities. When the business activities are considered as a whole, 37% of the companies report that they have to a large extent achieved satisfactory performance in 2003, while 26% state that they have only done so to a limited extent. Well over half of the companies expected to achieve satisfactory performance in 2004. Fifteen percent of the companies which took part in the preliminary study have been declared bankrupt or closed down.

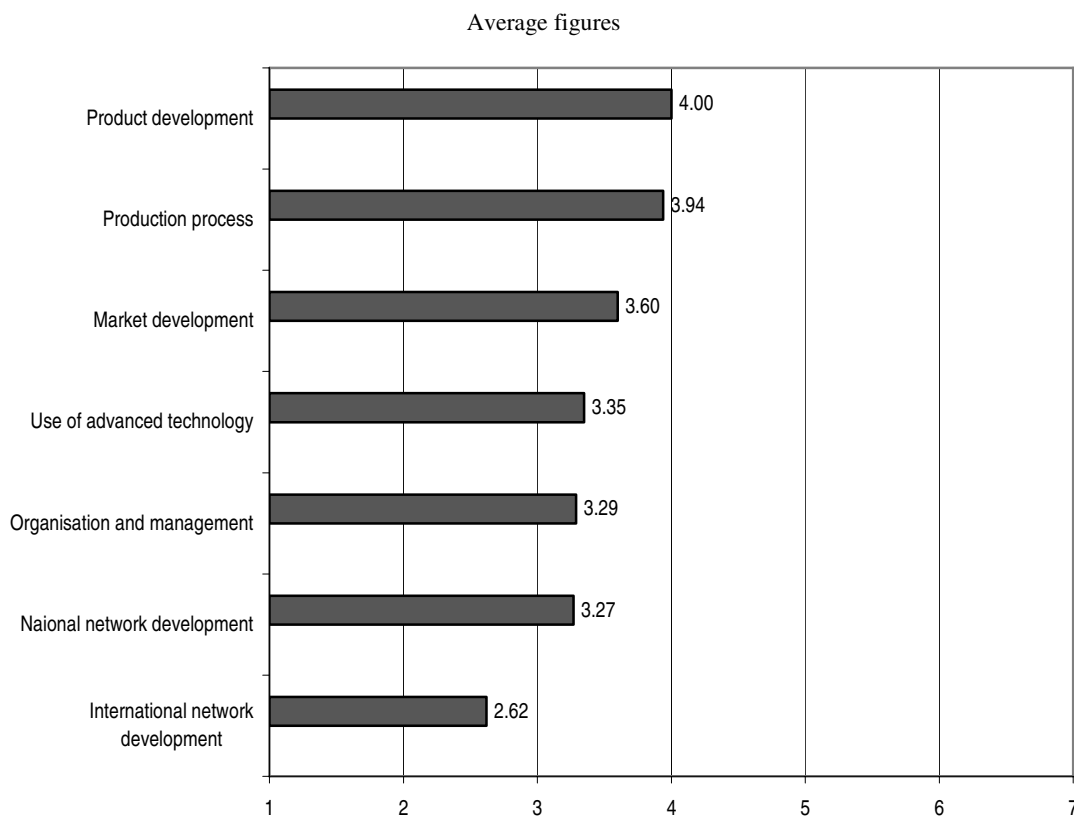
The importance of the projects for competence enhancement, innovation and collaboration

The study shows that the projects have made important contributions with respect to competence enhancement, innovation and increased collaboration with other companies as well as educational and research institutions.

Contribution to increased competence

Overall, just over two-thirds of the companies have found that their projects have contributed to a large extent to an increase in competence in one or more of their areas of expertise. The companies state that the largest competence effect is related to product development and production processes and routines, with market development in third place. The projects have resulted in the lowest degree of competence enhancement with regard to the development of national and international networks (see Figure 10.2).

Figure 10.2. **The project's contribution to increased competence in the companies**



Note: Scale of 1-7, where 7 is the highest value.

However, there are considerable variations depending primarily on which support scheme is used to finance the projects, while differences are also evident in relation to the industry, company size and support zone. Generally, it can be said that for recipients of national venture capital loans and development grants, OFU/IFU and regional development grants, the projects have led to enhanced competence in the fields of *product development* and to some extent *market development*. As regards projects financed by agricultural support and regional venture capital loans, enhanced competence has primarily been experienced in the field of *production processes and production routines*. For recipients of secured loans and basic financing loans for fisheries operators, enhanced competence in the field of *the use of advanced technology* shows the highest scores. On the whole, the achieved competence contributions are somewhat lower than were expected by the companies at the start of the projects (see Table 10.4). However, the variations are not large and indicate that the companies have realistic expectations of their projects' significance in this respect. Here too there are differences between the ex ante and ex post situations, depending on which support type is used. For four of the support types, OFU/IFU, national and regional venture capital loans, and basic financing for fisheries operators, there is agreement between expectations and achieved competence contributions, while the expectations are fulfilled to a lower degree for projects financed by secured loans and grants (regional and national). For the agricultural support schemes, already low expectations become even lower ex post.

Table 10.4. **Support scheme and the projects' contribution to competence enhancement ex ante and ex post**

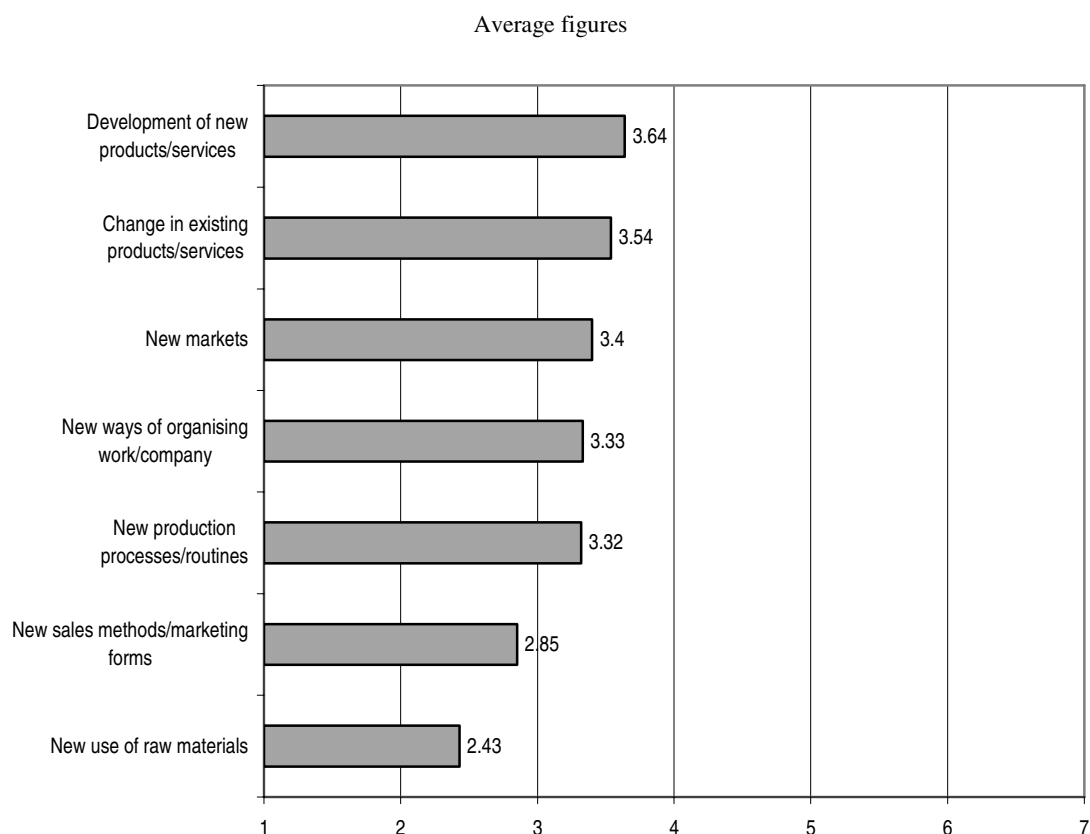
Respondents scoring 5-7 (n=481)

	Ex ante (before)		Ex post (after)		Change (percentage points)
	%	Number	%	Number	
Secured loan	82	18	73	16	-9
National venture capital loan	90	17	90	17	0
Regional venture capital loan	78	46	76	45	-2
National development grant	95	20	86	18	-9
Regional development grant	81	81	71	71	-10
OFU/IFU	93	40	95	41	+2
Basic financing for fisheries	46	15	46	15	0
Agricultural loan	51	36	59	42	-9
Rural development funds	60	68	47	53	-7
Total	71	341	66	318	-5

Contribution to innovation

The projects have made the greatest degree of contribution to innovation with regard to development of new products and services and changes in existing products and services. The projects' smallest contributions to innovation have been in the use of new raw materials and the development of new types of marketing and sales methods. However, this kind of summary of all respondents obscures the considerable variations which first and foremost depend on which type of support they have received, and also with regard to other project and company characteristics (see Figure 10.3).

Figure 10.3. The projects' contribution to innovation



Note: Scale of 1-7, where 7 is the highest value.

Overall, for approximately two-thirds of the companies, the projects have provided a high degree of contribution to innovation in connection with one or more activities (See Table 10.5). There is considerable variation between the innovation contributions experienced by the different recipients of support as a result of the projects. The recipients who experience the greatest activity in the area of innovation are those companies which have received national venture capital loans and development grants or OFU/IFU support. The smallest number of contributions to innovation is found among the recipients of basic financing loans for fisheries operators, agricultural loans and rural development funds, where about half report that they have not increased innovation.

As regards the size of the companies, it is the smallest (0-10 employees) and the largest (more than 50 employees), which show the least innovation activity. The greatest innovation activity is found among the companies in the group with 11-20 employees.

Table 10.5. **Number of contributions to increased innovation according to scheme of support ex post: companies whose reply was “to a large extent”**

(score 5-7), % (n= 449)

Support scheme	Number of contributions to increased innovation					
	1-2	3-4	5-7	Total contr.	No contr.	N
Secured loan	32	21	21	74	26	19
National venture capital loan	42	42	5	89	11	19
Regional venture capital loan	32	20	23	75	25	56
National development grant	14	52	19	86	14	21
Regional development grant	30	24	14	68	32	93
OFU/IFU	24	39	22	85	15	41
Basic financing for fisheries	46			46	54	24
Agricultural loan	37	10	6	52	48	71
Rural development funds	35	7	11	53	47	105
Total	33	19	13	65	35	
N	147	86	60	293	156	449

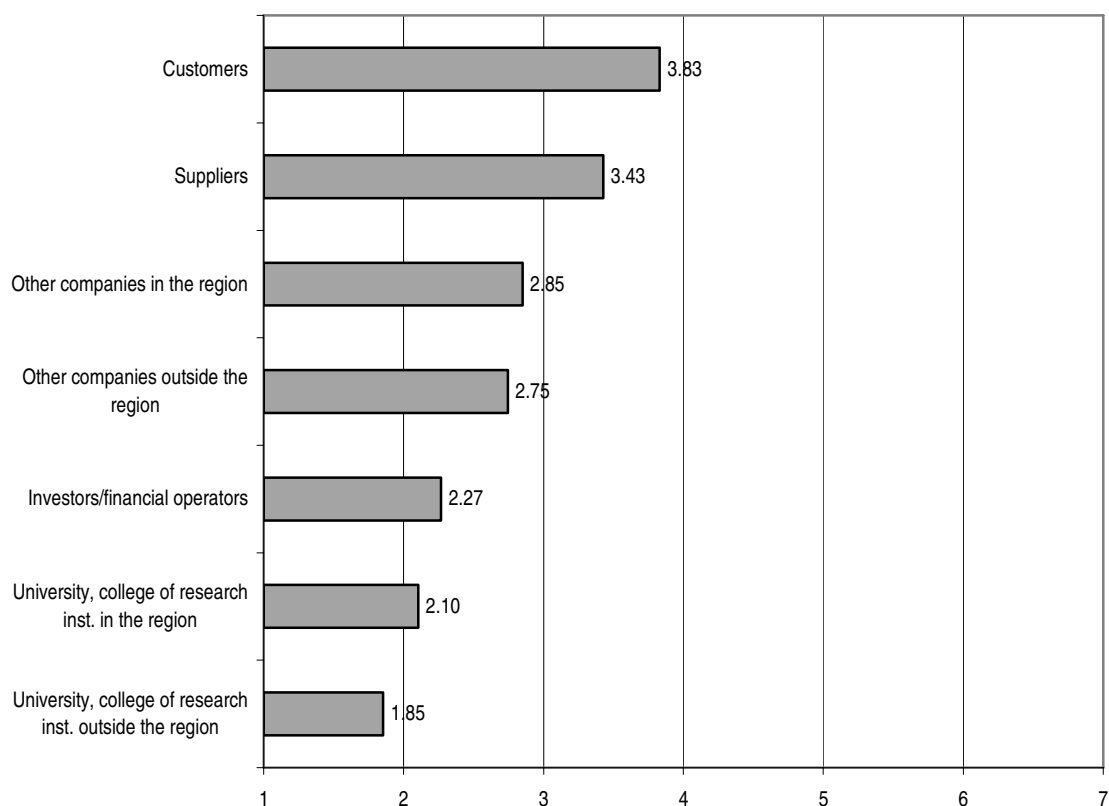
Contribution to increased collaboration

Innovation is not simply something which occurs within a company; it is also affected by factors in the surroundings. The regional innovation system concept has been developed for the purpose of explaining what creates innovative behaviour among the region's financial operators, managers and employees, and which combination of companies and institutions, as well as structural connections between these, are needed to create the innovative behaviour. The research has revealed a number of operators in this connection. In other words, the system of which a company is part of has significance with regard to achieving increased innovation. In this study the contribution has been greatest with regard to customers and suppliers, and to other companies in the region (see Figure 10.4).

Projects financed by the national support schemes, national venture capital loans and OFU/IFU obtain higher scores with regard to the majority of collaborative relationships than those financed by the other schemes of support. It is also here that most contact with universities, colleges and research institutions is found, as well as with companies outside the region. Projects financed by the support schemes for primary industry (agriculture and fisheries) obtain the lowest scores with regard to the largest number of collaborative relationships (see Table 10.6).

Figure 10.4. The projects' contribution to increased collaboration

Average figures (n= 450-463)



Note: Scale of 1-7, where 7 is the highest value.

Table 10.6. Collaboration contribution according to support scheme

Average figures

Support scheme	Customers	Suppliers	Companies		Universities, colleges or research institutions		Investors/financial operators	N
			In the region	Outside the region	In the region	Outside the region		
Secured loan	4.22	3.74	3.00	2.74	2.11	2.58	2.53	18-19
Nat. venture capital loan	5.26	4.05	3.53	3.79	3.37	2.26	3.05	19
Regional venture capital loan	4.46	3.91	3.19	3.37	2.57	2.13	2.68	56-57
National development grant	5.00	4.10	2.67	3.95	3.40	2.70	3.43	20-21
Regional development grant	4.07	3.29	3.14	3.05	2.01	1.86	1.93	93-98
OFU/IFU	5.19	4.47	3.14	3.63	3.09	2.81	3.35	43
Basic financing for fisheries	2.85	3.86	2.46	2.23	1.92	1.74	2.52	23-28
Agricultural loan	2.54	2.58	2.37	1.90	1.68	1.31	1.96	71
Rural development funds	3.30	3.03	2.59	2.04	1.40	1.34	1.64	106-109
TOTAL	3.83	3.43	2.85	2.75	2.10	1.85	2.27	
	462	463	462	459	453	450	456	

Note: Scale of 1-7, where 7 is the highest value.

On the whole, the projects have resulted in a considerable degree of increased collaborative activity in at least one field for more than 60% of the companies. The recipients who experience the greatest activity in the area of collaboration are those companies which have received national venture capital loans or OFU/IFU support. Ninety-two to ninety-five percent of these companies report that they have experienced one or more collaboration contribution. The smallest number of contributions to collaboration is found among the recipients of basic financing for fisheries operators, agricultural loans and rural development funds, where about half to two-thirds report that they have not achieved any significant results.

Effects on employment and IN's costs per job

One of the objectives of IN is to contribute to increased employment in the companies receiving support. Among the companies examined there has been a net increase in employment of 750 jobs (15%) in the period from 1 January 2000 to 1 January 2004. Of this net increase in employment, 398 jobs were created in companies in the regional policy support area and 352 outside this area. The percentage increase has been virtually the same inside (15%) and outside (14%) the support area.

Calculations performed for the entire population, in other words all companies receiving funding approval from IN in 2000 (7 354 projects) provide an estimated total effect on employment of from 6 300 to 7 500 new jobs. This corresponds to 0.9 to 1.0 jobs per project. More than 55% of the created and secured jobs have originated in the regional policy support area. However, these calculations involve a large margin of uncertainty. The accuracy of the estimates will depend both on the uncertainty of selection and on precision problems connected with the subjectively graded response alternatives used.

For the entire population of companies which received approval for IN funding in 2000, IN cost per job created or secured was from EUR 27 530 (NOK 223 000) to EUR 32 960 (NOK 267 000). This is broadly within the same interval as the previous year's estimate of EUR 26 540 (NOK 215 000) to EUR 34 074 (NOK 276 000) per job.

Changes in the characteristics of the companies

In the above we considered factors associated with the projects in the companies. In this section we will consider in detail whether developments or changes have taken place in the characteristics of the companies between the preliminary study in 2001 and the follow-up study in 2004. We will go on to consider in detail factors relating to the companies' resources, strategic conditions and entrepreneurial attitude. This last characteristic can provide some indication of the companies' attitude towards innovation, readiness to assume risk, and proactiveness.

Changes in the companies' resources

Resources are often grouped in five main categories: financial, physical, human, organisational and technological resources. Of the abovementioned it must be assumed that those with the greatest potential for development and change (innovation and entrepreneurial behaviour) are human and technological resources. At the same time, the financial resources must be considered fundamental for success. In this study we have considered indicators which can provide a picture of the various resources of the companies. These are presented below:

- Human resources: managers' and employees' networks (Network).
- Organisational resources: formal structure/board and strategy (Board).
- Technological resources: patents and non-duplicable competence (Technology).
- Physical resources: geographical location factors and business environment (Location).
- Financial resources: financial position compared with competitors (Finance).

All the resource groups show a reduced average value since the time of the preliminary study. This was also evident in the follow-up study in 2004. However, the reductions compared with the assessment of the same resources in the preliminary study are not large (between 0.50 and 0.20 on a scale of 1-7). The resources which are rated highest are network resources, with average values of 4.66 and 4.99. The remaining resources achieve average values of between 2.6 and 4.8 when both studies are considered together, with the technology resources achieving the lowest score. All changes from the preliminary study to the follow-up study are significant at the 10% level or higher. Another way to study the change in a resource is to consider how many companies estimate the resources to be lower, higher or at the same level as previously. Between 28% and 35% of the companies consider the value of the various resources to be greater today than in 2001, while the majority consider their value to be lower (46-57% of the companies, depending on which resource is considered). Between 8% and 26% of the resources are considered to be unchanged in value. Hence it can be said in general that approximately half the companies place the same or a higher value on their resources compared with 2001.

All the different resource indicators mentioned above must be assumed to be important to the companies, but why have the values fallen relative to the preliminary study? It is difficult to form a clear opinion about this. One possible explanation is that at the start of a project there is a tendency to respond more optimistically to questions than after the project has been completed. Another possibility is that there have actually been real changes in the companies' assessment of the resources in recent years, and in this connection the project in question may influence the companies' focus and appraisals. In other words, after the completion of a project, the focus changes and other factors may assume greater importance.

Changes in the competitive strategies of the companies

The choice of competitive strategy is often considered one of the most important decisions for the success of a company, and a crucial objective in the fields of strategy and management is to develop know-how about different sources of sustainable competitiveness. Competitive strategies are often grouped into three main categories depending on the focus of the strategy. Traditionally they can be grouped according to whether the focus is on product, market or price. This study has considered indicators which can provide a picture of the strategic orientation of the companies, using the above mentioned grouping.

Also here, all the groups show reduced average value compared with the figures from the preliminary study (between 0.23 and 0.50). The reduction is least for price strategy, while the other two strategy groups show a reduction of 0.50. The highest-rated strategy group is product strategy, with average values of 5.26 and 4.76. The lowest value is for

market strategy, with values of 3.78/3.28. The comparisons between the preliminary and follow-up studies are significant at the 10% level or better. When looking at how many companies rate the strategy areas lower, higher or unchanged, the companies have in particular increased their rating of the importance of the price strategy. Forty-four percent give this a higher rating than in the preliminary study, while 36% rate it lower. The corresponding figures for market strategy and product strategy are 31% with higher rating and 60% with lower. In other words it would appear that a relatively large change in strategy focus has occurred in the period, particularly with regard to the importance of price strategy.

Changes in the entrepreneurial orientation of the companies

Entrepreneurship and innovation are considered important for value creation, growth and employment. In addition it is expected that social development will increasingly be marked by processes of adjustment, which to an increasing degree means that entrepreneurial capability will be important. Entrepreneurial orientation can be defined as: “The manager’s strategic orientation which reflects a company’s willingness to involve itself in entrepreneurial activity”, and is seen as a company’s actions in respect to innovation, readiness to assume risk, and proactiveness. One of the objectives of IN and several of the types of support available is precisely to contribute to development, innovation and creativity. It is therefore interesting to discover the nature of this factor and the way in which it develops. The six indicators comprising entrepreneurial orientation are here grouped according to indications for innovation, proactiveness and readiness to assume risk, and the results are shown in Table 10.7.

Table 10.7. **Entrepreneurial orientation variables**

Innovation	• The company is engaged in the development of new products/services. • We aim to be first with regard to technological development in our industry.
Proactiveness	• We make efforts to find new potential in the market. • We emphasise the importance of the continual development of our business concept. • The company emphasises the importance of being the first to venture into new markets.
Readiness to assume risk	• We accept high risk in our market adaptation.

Here too the average value is lower than in the preliminary study (0.48). The difference between the preliminary and follow-up studies is significant. When looking at how many companies rate the strategy areas lower, higher or unchanged it can be seen that between 22% and 28% of the companies rate their entrepreneurial orientation higher than previously, while between 36% and 49% rate it lower than at the time of the preliminary study. For between 26% and 36% of the companies, the rating of the entrepreneurial factors is considered to be unchanged. It should be noted that the companies tend to rate the entrepreneurial factors the same as in 2001 to a larger extent than they do for resources and strategy. Generally it can be said that the rating of between half and two-thirds of the companies is the same as or higher than in the preliminary study.

Since entrepreneurial orientation can be important for a company’s development and performance and for IN’s work and a number of the support schemes, the possible connections between IN’s involvement and the companies’ entrepreneurial orientation is considered more closely. The dependent variable of the analysis is the companies’ entrepreneurial orientation in 2004. It is interesting to note that the support types which can be characterised as the most development-oriented, that is OFU/IFU and the national

and regional development grants and venture capital loans, also appear to be the ones which influence the entrepreneurial orientation of the companies. Moreover there is a correlation between the IN's contribution in the form of follow-up and the entrepreneurial orientation. Changes experienced by a company in its surroundings in the last three years are also clearly related to the entrepreneurial orientation. The model explains 35% of the variation in entrepreneurial orientation (adjusted $R^2 = 0.35$) (see Table 10.8).

Table 10.8. **Regression analysis: IN's influence on the companies' entrepreneurial orientation**

Variables	Entrepreneurial orientation 2004
Background variables	
Company size	
Changes in the industry in the last three years	0.395***
Types of support	
Secured loan	
National venture capital loan	0.208***
Regional venture capital loan	0.109*
National development grant	0.176**
Regional development grant	0.155**
OFU/IFU	0.296***
Basic financing for fisheries	
Rural development funds	
Other IN contributions	
Importance of guidance for the project	
Follow-up of the company	0.103**
Project allocation compared with sales in 2000	
Constant (B value)	-0.219
Adjusted R^2	0.35
F-value	14.75***
N	326

Note: Significance: * < 0.10; ** < 0.05; *** < 0.001.

Factors which influence the companies' performance

Regression analyses have been carried out to explain variations in the development of *performance*³ compared to competitors, *sales trend*⁴ and *employment trend*⁵. These analyses provide IN with input with regard to factors of which it is important to be aware of with an eye to improving company performance. The results show in particular that a company's entrepreneurial orientation has a significant effect on performance (see Table 10.9).

3. *Performance* is measured in terms of whether the companies have reported that they perform better than the competitors with regard to financial results, growth and market conditions. It consists of six variables which appear as one factor when using factor analysis (the procedure is described in an attachment).
4. Change in sales from 2000 to 2003, divided by sales in 2000.
5. Change in employment from 2000 to 2003, divided by employment in 2000.

Among the recipients of *ordinary support*, it is particularly industry-related changes in the past three years, entrepreneurial orientation and the use of the resources of the Board which have had a positive effect on the companies' *performance* in relation to their competitors. The *sales trend* of the companies is positive with increasing scope of project funding from IN, while the *employment trend* is positive in relation to changes in industry-related conditions and the use of networks. On the other hand, company size has a negative effect on employment trends. This means that large companies develop to a greater extent through rationalisation.

Table 10.9. **Regression analysis: factors of significance for the companies' performance, sales and employment trends**

Users of ordinary support schemes⁶

Variables	Performance compared with competitors	Change in sales (relative)	Change in employment (relative)
Control variables			
Company size			-0.149*
Surroundings-related variables			
Changes in the industry in the last 3 years	0.193**		0.285**
Company characteristics (at project commencement)			
Network (2000)	0.180*		
Board (2000)		-0.176*	
Location (2000)		0.218**	
Entrepreneurial orientation (2000)	0.217**		
Changes in company characteristics			
Network (higher and unchanged)			0.162*
Board (higher and unchanged)	0.175**	-0.186**	
Location (higher and unchanged)			
EO (higher and unchanged)	0.218**		
IN's contribution			
Importance of guidance for the project			
Follow-up of the company			
Project allocation compared with sales in 2000	-0.178**	0.392***	
Constant (B value)	-2.19	92.77	-2.38
Adjusted R ²	0.27	0.18	0.09
F-value	4.13***	2.84***	1.77**
N	153	152	148

Note: Significance: * < 0.10; ** < 0.05; *** < 0.001

6. Secured loans, national and regional venture capital loans, national and regional development grants and OFU/IFU.

For *start-up businesses* there are many factors which are of significance for the *performance* of the company in relation to the competitors. It would appear to be of particularly positive significance that the start-up businesses have maintained or increased their entrepreneurial orientation. The location of the companies also plays a role, as well as the intensity of competition and the dynamics of the business environment. For those using *agricultural support* there are three factors which have a significant positive effect on the *performance* of the company in relation to the competitors. These are how dynamic the commercial surroundings are, the entrepreneurial orientation at the initiation of the project and whether or not the entrepreneurial orientation is considered to be higher than or at the same level as during the preliminary study.

An increase in entrepreneurial orientation (EO) appears to be important for a company's results. This is most clearly seen with regard to a company's *performance* compared with that of the competitors, where the analyses show significant correlations and where all the average values are highest for the group with higher EO. It is interesting to note that this also applies to the *employment trend* for recipients of agricultural support. Here the average figures can be interpreted as indicating that those with higher EO have increased their employment by 33%, while the corresponding figure for those with lower or unchanged EO is only 8%. The initial level is presumably very low here, so the total number is hardly very large, but it is nevertheless interesting that we find such variations, depending on the rating of EO over a period. As regards *sales trend*, no significant differences are found, and it is therefore impossible to interpret these with any confidence (see Table 10.10).

Table 10.10. The importance of change in a company's entrepreneurial orientation (EO) for the company's results, according to support group (ANOVA analysis)

Rating of EO	Performance compared with competitors		Change in sales (relative)		Change in employment (relative)	
	N	Average	N	Average	N	Average
Ordinary support						
Lower/unchanged EO	163	0.21	127	116.55	145	0.38
Higher EO	75	0.50	64	0.98	74	0.38
ANOVA (F)		4.29**		0.63		0.00
Agricultural support						
Lower/unchanged EO	83	-0.36	48	0.63	78	0.08
Higher EO	58	0.00	32	0.68	55	0.33
ANOVA (F)		5.51**		0.04		11.69**
Start-up grant						
Lower/unchanged EO	60	-0.43	34	24.55		
Higher EO	21	0.76	14	11.76		
ANOVA (F)		26.76***		0.14		

Note: Significance: * < 0.10; ** < 0.05, *** < 0.01

Analyses have also been carried out to examine the connection between the companies' results and the type of support received. These analyses show that a large number of the funding schemes are of significance for performance, especially with regard to performance compared with the competitors.

Concluding comments

This section summarises the results achieved by the recipients of support in certain fields which are especially important with regard to IN's objectives as presented in the beginning of this chapter. The result indicators in this connection are: Project financing (share of financing), IN's importance for the projects (additionality), importance for profitability and survival, contribution to innovation, competence and collaboration and employment effects. For a thorough examination of the results for each type of support see Madsen and Brastad (2005).

The support schemes with the highest result indicator scores

The support schemes have different objectives and target groups and they also function differently. Table 10.11 illustrates this by showing which scheme of support obtains the highest scores for the various indicators discussed above. Six of the nine support schemes are represented in this "high score list" (number of first places in parentheses). National venture capital loans (4), OFU/IFU (4), basic financing loans for fisheries operators (3), regional venture capital loans (2), national development grants (2) and the agricultural support schemes (1).

Table 10.11. **Comparison of support types : high score list for the result indicators**

Result indicators	Support scheme
Project financing	
IN's share of financing (average)	Basic financing for fisheries
Banks' share of financing (average)	Regional venture capital loan
IN's importance for the projects	
Project realised only with IN financing	National venture capital loan
Project realised even without public financing	Basic financing for fisheries
IN provided follow-up after the approval of the support	OFU/IFU
Importance for profitability and survival	
The importance of the project for survival today	National venture capital loan
The importance of the project for development of profitability	Basic financing for fisheries
The project's contribution to revenue increases/cost reductions	Regional venture capital loan
Achieved satisfactory results last year*	Agricultural support schemes*
Contribution to innovation, competence and collaboration	
Contribution to competence enhancement (in from 1 to 7 areas)	National development grant
Contribution to innovation (from 1 to 7 innovation indicators)	National venture capital loan
Contribution to collaboration with others (1 to 7 collaborative activities)	National venture capital loan
Proportion of companies with entrepreneurial attitude	OFU/IFU
Employment effects	
Projects where IN has been important for employment trends	OFU/IFU
Average number of created jobs	OFU/IFU
Projects where IN has been important for securing of jobs	Basic financing for fisheries
Average number of secured jobs	National development grant

Comparison of the support schemes: concluding comments

Two of IN's most important objectives are to contribute to competence development and innovation and to contribute to profitable companies. One way of summarising and evaluating the support types is to consider to what degree they contribute to these central objectives. In the following we compare the contributions of the various types of support. Kirchhoff (1994) has created a model which uses innovation level and growth level as dimensions for categorising types of companies according to the scores they achieve for these dimensions. This "dynamic capitalism typology" model is shown in Figure 10.5. The model consists of a 2x2 matrix showing the abovementioned dimensions measured on a scale from low to high. *Window 1* (low innovation and low growth) is known as the *economic core*. Small companies whose growth and development have stopped after the owner has achieved his objectives will often end up here. Companies in *window 2* (low innovation and high growth) are known as *ambitious* companies. These companies are considered to have grown rapidly on the basis of a few earlier innovations. However, the growth will often slow as the novelty of the innovations wears off. Companies in *window 3* (high innovation and low growth) are known as *limited resource* companies. The high rate of innovation necessitates a decision as to whether one wishes to implement it, and perhaps most important of all is the question of access to new resources and their costs. The result of this may be that limitations in the availability of resources arise (for example, R&D, although it often leads to innovations, can be expensive) or there may be self-imposed restrictions (the desire to keep control). Companies in *window 4* (high innovation and high growth) are known as *glamorous* companies. These can be considered entrepreneurial and having great potential.

Figure 10.5. Dynamic capitalism typologies

	Low	High
High	3. Limited resource	4. Glamorous
Low	1. Economic core	2. Ambitious

To what extent the IN support contributes to steering the companies in such directions as shown in the model above is illustrated in Figure 10.6. Here a comparison has been made between the recipients of the various schemes of support, with the exception of those receiving start-up grants, who were not asked all the questions. One index (average) has been created of the results for each scheme of support as regards profitability and survival⁷ and one (average) of the results for innovation, competence and collaboration.⁸ The average for all participants was used as the division between high and low. Based on this, the average for profitability is 55 for all schemes of support and the equivalent for innovation/competence is 71.

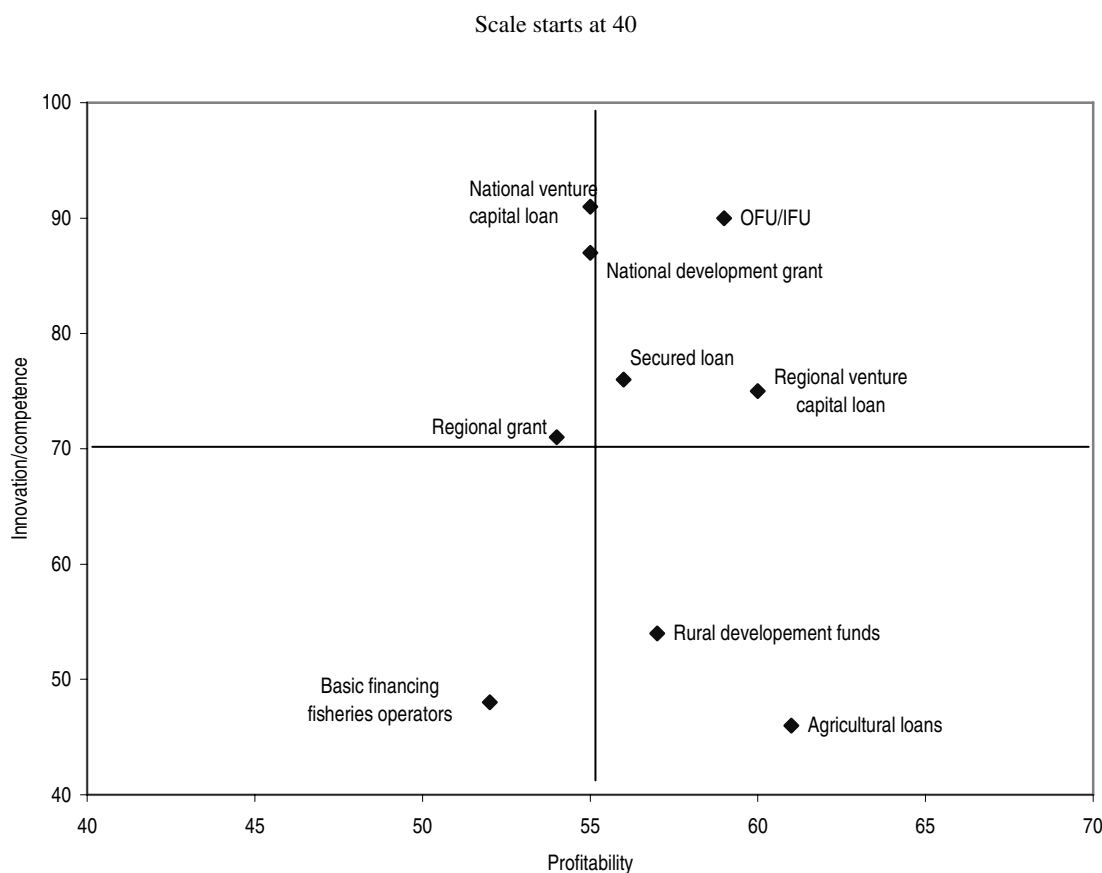
7 The importance of the project for survival today; the importance of the project for development of profitability; the project's contribution to revenue increases/cost reductions; satisfactory results achieved last year.

8 Contribution to competence enhancement (from 1 to 7 areas); contribution to innovation (from 1 to 7 innovation indicators); contribution to collaboration with others (from 1 to 7 collaborative activities).

From Figure 10.6 it is evident that it is the national support schemes which first and foremost appear to have innovative effect, but it is perhaps somewhat surprising that they generally are at an average level as regards profitability. The types of support which are of greatest importance with regard to profitability are the agricultural schemes, regional venture capital loans and OFU/IFU. Basic financing for fisheries operators has neither innovative/competence enhancing effect nor does it contribute particularly to profitability compared with the other types of support.

Using the typologies above we can say something about the contribution of IN support to the directions in which the recipients move. Recipients of basic financing loans for fisheries operators are found in *window 1: economic core* companies (low innovation/competence and low profitability), while recipients of agricultural support are found in *window 2: ambitious* companies (low innovation/competence, high profitability). Companies which have received regional development grants are found in *window 3: limited resource* companies, and also lie right on the boundary with *window 1*. Recipients of national venture capital loans and national development grants lie right on the boundary between *window 3* and *window 4*. In *window 4: glamorous* companies (high innovation/competence and high profitability) are found companies that have received OFU/IFU, secured loans and regional venture capital loans. This is illustrated in Figure 10.6.

Figure 10.6. **Proportion of companies which have achieved innovation/competence and profitability through projects, according to scheme of support**



The figure clearly illustrates that the support schemes are different and address the central objectives in different ways. This review can therefore form a basis for discussion of whether support is correctly allocated according to the objectives for the individual type of support and relative to the other types. Among other things, the support schemes which have ended up in *window 4* appear to meet the expectations well, while one could question whether national venture capital loans and development grants should not have had a better effect on the companies' profitability and whether basic financing for fisheries operators is allocated as one should expect. Similar reasoning can be applied to the other support schemes.

Annex 10.1

Objectives for the financial support schemes

Secured loans

The *secured loan scheme* is used to partially finance commercially profitable innovation, development, business start-up and reorganisation. Loans are granted on commercial terms, normally with property as security at some level of priority. What distinguishes IN's secured loans from loans of the same type provided by other financial institutions is the long-term nature and flexibility of the repayment terms.

National venture capital loans

National venture capital loans are intended to partially finance socio-economically profitable expansion, modernisation, reorganisation, development and start-up projects in Norwegian trade and industry. Loan loss provision is associated with the scheme, making it possible to assume higher risk than could be financed through the private loan market. Venture capital loans are therefore a special loan arrangement for projects with higher risk than would be catered for by the ordinary financial institutions. As with secured loans, venture capital loans can finance investments in operating equipment and buildings, but the objective must be increased efficiency or expansion. In addition, venture capital loans may cover expenses in connection with mergers, structural and collaborative initiatives, the introduction of new technology or the utilisation of R&D results, as well as reconstruction/refinancing, restructuring or reorganisation.

National development grants

The objective of *national development grants* is to promote initiatives and projects which form a foundation for growth and reorganisation in Norwegian trade and industry. Highest priority is given to projects and initiatives which contribute to development and start-ups, reorganisation, network building and competence enhancement. The grants can cover up to 50% of external costs. Development grants also finance programmes and initiatives directed at individual industries, with the principal share aimed at small and medium-sized companies.

Public and industrial research and development contracts (OFU/IFU)

The objective of the public and industrial research and development contract (OFU/IFU) scheme is to stimulate R&D collaboration between a customer company and a supplying company with regard to the development of new products, processes, methods or services. The use of this type of support shall stimulate the development of industrial networks and communities which can facilitate innovation and the development of competitive products with small and medium-sized Norwegian companies playing an important role.

Regional venture capital loans

Regional venture capital loans are intended to help promote development of competitive and profitable trade and industry in districts with particularly serious employment problems and/or a poorly developed commercial foundation. This takes place through the stimulation of company start-ups, continued development and reorganisation of existing companies and competence enhancement within companies. This type of support can be awarded in zones A, B and C of the regional policy support area. The rates of support are differentiated between the three zones, with zone A having highest priority.

Regional development grants

The objective of the regional development grants is the same as for regional venture capital loans. This type of support consists of investment grants and company development grants. *Investment grants* are primarily used for the partial financing of physical investments, while *company development grants* are used for all types of comprehensive development initiatives in companies located in the regional policy support area.

Start-up grants

The objective of *start-up grants* is to stimulate increased business start-up activity so as to create more permanent, profitable jobs. The grant is a scheme for small business founders in all parts of the country, but with particular emphasis on the rural regions. Among the projects with potential for creating such jobs, priority is to be given to those involving commercially underdeveloped areas, women, the unemployed and the occupationally disabled.

Basic financing for fisheries operators

This is a secured loan scheme. The loans can be awarded in connection with the building and conversion of fishing vessels and for the purchase of used vessels and investment in equipment. Loans may also be provided for development projects. The loans are granted with security in vessels and equipment, often with co-financing by private banks. Until the year 2000, the loan scheme was only used for the financing of fishing vessels. However, in Parliamentary Report No. 36 (2000-2001), the Norwegian government proposed that the scheme be changed to a *basic financing scheme for fisheries purposes* which can be used for projects which promote marine industrial development, including the financing of fishing vessels.

Agricultural loans

Interest-bearing loans can also be granted for investment initiatives, resulting in the provision of an overall financing package for projects. The loans can be granted for investments in such things as work premises, expansion of commercial operations, purchase of additional space and transfer of property, environmental initiatives, reindeer husbandry and various agricultural purposes.

Rural development funds

The rural development fund scheme is intended to contribute to the promotion of profitable commercial development in rural areas and in connection with agriculture. The funds can be used for investment in traditional agriculture and for development initiatives and commercial development associated with agriculture. Framework conditions apply for each Norwegian county as well as a framework for centrally administered funds. The centralised rural development funds are used in project-oriented activities and initiatives that are nationwide in character, and primarily for skill development and R&D initiatives.

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Chapter 11

BEHAVIOURAL ADDITIONALITY OF THE UK SMART AND LINK SCHEMES

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Abstract. The concept of behavioural additionality emerged as an observed phenomenon in early evaluations of collaborative R&D programmes when it was found that the usual concepts of additionality did not fully capture the effects of programmes on firms. In this chapter we assess the impact of government subsidies for R&D performed by technology-based SMEs. We are concerned with the context of direct support for specific R&D projects, rather than indirect support. The chapter considers some key aspects of firm technology strategy, and hence the dimensions in which firm behaviour may be affected. Exploratory research findings are presented based on interviews conducted with managers of technology-based SMEs in the United Kingdom. In strategic terms the research findings highlight some important issues relating to the question of how public support for R&D interacts with and affects the technology strategies and capabilities of smaller firms. In some cases this type of industrial R&D support helps firms to overcome a lock-in failure by introducing a firm to a new or extended technology or market area. It helps firms to build new networks and helps them to build up credibility at an international level. For these firms, public R&D support is vital in areas core to present and future firm strategy and is seen to enhance their innovation drive in some significant ways.

Introduction

The United Kingdom has a long history of direct public support for R&D projects carried out by firms. In recent years this has been concentrated on supporting small and medium-sized enterprises (SMEs) through specific measures such as the SMART and LINK programmes. Evaluation of the impact of such programmes at first centred on the narrowly-defined achievements of support in producing specific innovative products, processes, knowledge or other results. The limited frame of this type of evaluation is being enhanced by behavioural additionality (BA) evaluation perspectives that address broader changes in company activities resulting from public support. This chapter introduces a small pilot study using the BA approach to investigate the impacts of the SMART and LINK programmes on a number of SMEs, and discusses the merits of this approach.

* The UK Government's Department of Trade and Industry funded the research project, of which the findings are presented in this chapter. The authors thank all the participating companies and organisations for their support and advice.

The authors who conducted the study were particularly interested in exploring the phenomenon of behavioural additionality by investigating the lagged effect of public R&D support on strategic behaviour of firms for a sample of UK firms from different industrial sectors. It is worth stressing that many SMEs do not have a formal R&D function, so public R&D grant support can be seen here to aid the diffusion and adoption of new knowledge and technology and more incremental innovations in supporting firm competitiveness (Bessant, 1994). North *et al.* (2001) confirm that SMEs are constrained by their limited internal resources, particularly with respect to finance, management resources and their knowledge base, compared with larger firms. Limited financial resources clearly make it harder for smaller firms to support and to reap the benefits of innovative activity, particularly in terms of R&D and the marketing of new product innovations. In this respect the difficulties that small technology-based firms face in gaining external finance to support innovation has been the subject of considerable attention in the UK during the last decade (Bank of England, 1996; CBI, 1997; HM Treasury, 1998).

The concept of behavioural additionality emerged as an observed phenomenon in early evaluations of collaborative R&D programmes when it was found that traditional formulations of additionality did not capture well the effects of programmes on firms (Buisseret, Cameron and Georghiou, 1995). In simple terms the range of perspectives on additionality is:

- *Input additionality*: a concern with whether resources provided to a firm are additional, that is to say whether for every pound provided in subsidy or other assistance, the firm spends at least an additional pound on the target activity.
- *Output additionality*: the proportion of outputs which would not have been achieved without public support.
- *Behavioural additionality*: the difference in firm behaviour resulting from the intervention.

The behavioural perspective is multi-layered. At its simplest it is confined to the funded project and is manifested through questions relating to whether the support caused the firm to increase the scale of its activity in the chosen area, its scope in technological or other terms, and whether timing was affected (*i.e.* did the resources allow acceleration of development?). A typical characteristic of smaller firms is their distinctive organisational culture, stemming from the combination of ownership and management that typifies the majority of SMEs. Hence, North *et al.* (2001) stress the need to understand the role of the individual traits of the owner-manager in the way in which the business is managed and developed, which in turn affects management behaviour, attitudes to risk (and hence innovation), and the nature and extent of external financing that is sought. These attitudinal and behavioural characteristics all have potential implications for the nature and extent of the support needs, as well as effective delivery of external support to small companies.

Public support of industrial R&D in firms

Experience suggests that targeted government financial support of new technology-based firms (NTBFs) may be necessary in specific strategically important instances if private sector financiers are unwilling or unable to take forward viable investment opportunities (Oakey, 2003). Also whilst large firms with their substantial financial resources generally tend to take a ‘portfolio approach’ to technological progress in which one or two ‘winner’ projects may emerge from an R&D portfolio of inventions and innovations, NTBFs are often restricted to a single new product development on which the fortunes of the company solely depend (Rothwell and Zegveld, 1982; Oakey, 1984). Oakey (2003) contends that from an industrial additionality perspective, government agencies should seek to promote R&D in NTBFs so that some firms involved in risky areas of technology development can then reach a point where they would be able to attract private sector venture capital or other forms of investment support. By this means, much needed additionality is obtained, and a greater potential for growth engendered. Such public sector involvement would not only help to increase the extent of risk, but would also fill gaps in other aspects of venture capital provision. For example, public sector involvement might ease the frequently noted problem of a funding gap of investments between GBP 50 000 and GBP 500 000 by particularly targeting joint projects at this area of need (Mason, McNally and Harrison, 1996).

Billings *et al.* (2004) confirm that studies comparing the effects of funding source on the productivity of R&D have been conducted both at the industry level (Mamuneas, 1999; Levy and Terleckyj, 1983) and at the firm level (Griliches, 1986). The industry-based studies are primarily focused on the issue of whether government funding of R&D ‘crowds out’ or complements privately funded R&D. The firm level studies report that firms are more productive with internal funds than with government funds. In Hall and van Reenen (2000) and David *et al.* (2000) overviews are given of econometric analyses on the efficiency of tax credits and direct R&D subsidies respectively. Hall and van Reenen (2000) conclude that studies on the impact of fiscal incentives for R&D on private R&D generally find that private R&D investments rises as tax credits are available. The rise is rather small in the beginning, though, but tends to increase in time (Janssens and Suetens, 2001).

This chapter assesses the impact of government subsidies for R&D performed by technology-based SMEs. We are concerned with the context of direct support for specific R&D projects, rather than indirect support. The surveyed companies were all recipients of the UK Government’s SMART award or LINK award. Schemes of those programmes are outlined hereunder.

SMART

The SMART (originally the Small Firms Merit Award for Research and Technology) scheme¹ was a national programme, which applied to eligible SMEs wherever they were located. Originally launched in 1986, SMART focused on supporting the development of new technology-based products that were ‘new’ within a sectoral or national context. Over subsequent years it evolved and incorporated other support measures across a range of sectors and technologies. Though the ‘SMART’ name is not used now, similar support measures and rationales are still in operation. The rationale is based on the view that there is a gap in the venture capital market as a result of reluctance of venture capitalists to make investments of less than about GBP 250 000 (Bank of England, 1996). SMART support entailed the provision of grants to enable companies with fewer than 50 employees to undertake feasibility studies to research the technical feasibility of concepts. The scheme also provides grants to enable all companies with fewer than 250 employees to undertake development projects to work-up concepts to pre-production prototype stage. The grants were awarded for single company projects, unlike many such grants that require collaborations between companies or with research organisations, including the LINK scheme.

LINK

The LINK award supports collaborative research and development projects between companies and the research base. Every project must include at least one business and one research base organisation. A ‘research base’ organisation covers universities, or other centres of research excellence such as research council institutes, government research agencies, hospitals and independent research organisations. LINK grants are provided by government to share the financial risk of the project with the aim of stimulating innovation, wealth creation and quality of life benefits. Businesses of any size and research organisations based in the UK can participate. Government provides up to 50% funding for core research projects, 75% funding for feasibility studies, and 25% for nearer market development projects. Universities are funded up to 100% of their marginal project costs from a research council.² Government funding is accessed through a number of programmes each focused on a different technology or sector³.

LINK has been the UK’s main method for public support of research collaboration between business and the research base, promoting partnership in pre-commercial research, aiming to stimulate innovation and thus create wealth and improve the quality of life. Research projects must involve collaboration between companies and research groups to develop new technologies. Its purpose was repeated by the Minister for Science and Innovation, Lord Sainsbury, in 2003: “*The problem addressed by LINK is that ideas*

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1. Since the study was undertaken, the SMART scheme has ended in England (though not in Scotland, Wales and Northern Ireland). There are four types of grant available to support different types of R&D project. Details are available at:
<http://www.businesslink.gov.uk/bdotg/action/detail?type=RESOURCES&itemId=1074469930>
(January 2006).
 2. Biotechnology and Biological Sciences Research Council (BBSRC), Engineering and Physical Sciences Research Council (EPSRC), Economic and Social Research Council (ESRC), Medical Research Council (MRC), Natural Environment Research Council (NERC), Particle Physics and Astronomy Research Council (PPARC).
 3. For further details see the Office of Science and Technology Web site: <http://www.ost.gov.uk/link/info.html>

don't just automatically flow from science into business. You cannot just publish brilliant research and expect it to be picked up and utilised by business. LINK provides pump priming at the interface, bringing together the business and academic communities and so allowing exploitation to flourish.”⁴

The scheme is made up of a family of individual programmes, each focussing on a particular market or technology category. For example, in June 2005, these were:

- Electronics/Communications/IT.
- Food/Agriculture.
- Biosciences/Medical.
- Materials/Chemicals.
- Energy/Engineering.

A number of collaborative research projects is within each of these programmes supports. Table 11.1 at the end of this chapter gives details of the open programmes (currently accepting new proposals) and completed programmes (closed to new proposals) in June 2005, showing the breadth of research areas addressed over the lifetime of LINK.

Programmes are each expected to last about five years and are focused on areas “of strategic importance for the future of the national economy”. They encourage work that is not yet marketable, but offers the prospect of commercial exploitation. One objective is to “offer opportunities for business and academia to develop partnerships, which often continue long after the project has finished, to acquire knowledge and develop new technologies together, which will help shape the future.”

Each programme is funded by one or more government departments and research councils, and has its own management structure. A programme manager is responsible for overall progress, with a programme management committee of industrialists and academics to select projects for support.

Strategic review of LINK collaborative research, 2003

LINK has existed for a surprisingly long period in much the same form, starting in 1986. Although frequently referred to as a ‘scheme’, it is more properly referred to as a ‘framework’.⁵ Although it has had enduring features, many evolutionary changes have been made over its lifetime. This was emphasised by the Strategic Review in 2003, which was required to consider the role of LINK and how it fitted into overall science and innovation programmes, to evaluate the benefits, and recommend any changes required. The “core principles” of LINK were defined by the Review:

4. Strategic Review of LINK Collaborative Research, September 2003, Foreword, p. 2.

5. Strategic Review of LINK Collaborative Research, September 2003, Recommendation 1, p. 5.

- It is collaborative research involving at least two partners – one business and one research base.
- The scientific quality of the research is maintained by peer review.
- It is pre-commercial.
- The maximum funding available from the public sector is:
 - 75% for feasibility.
 - 50% for core research.
 - 25% for development⁶.

These funding alternatives were introduced by the Review, in particular the development type, stressing the evolving nature of the framework.

Methodology of the behavioural additionality study

The methodological approach undertaken in the present study involved in-depth interviews with significant personnel within the companies that had received government R&D support through SMART or LINK awards. This study addresses the central issue of whether the government support caused the firm to increase the scale of its R&D activity in the chosen area and what impact the support has had on the strategic behaviour of the firm. The following strategic questions were formulated in order to design a semi-structured interview questionnaire guide:

- Whether the support helps to overcome a lock-in failure by introducing a firm to a new or extended technology or market area?
- Whether the support is building new networks or co-ordinating systematic innovations such as those requiring establishment of standards, either between firms or between firms and the research base?
- Whether the support has provided the firm with incentives to acquire new competencies, ranging from project management skills, through various acquired technological and market capabilities, and possibly encompassing innovation and commercialisation capabilities (for example securing intellectual property or raising venture capital investment)?

These effects may or may not be intentional on the part of either the policymaker or the recipient of funding. It is also of interest to assess the persistence of such effects. While input and output additionality operate at a point in time, behavioural additionality effects may be expected to endure beyond the period of R&D and to be integrated into the general capabilities of the firm (Georghiou, 2002).

This exploratory study consisted of interviews held with representatives of ten companies to form a base of case studies. The case studies included recipients of SMART awards and LINK awards. Interviews were held with senior managers or those directly responsible for the R&D project concerned. To obtain useful results with regard to the impact of R&D grants on company level strategy and behaviour, we mainly targeted companies who had successfully applied for awards in the late-1990s and where the SMART or LINK project had been completed at least three years previously. After

6. *Ibid.*, p. 6.

consulting the Department of Trade and Industry's SMART and LINK projects databases for projects completed before 2001, over 30 companies were contacted to establish if we could hold interviews with the relevant staff. Ten companies were selected after initially contacting them by letter followed up with e-mail correspondence or telephone discussion to confirm interview plans. The companies selected had conducted some form of research and development activity through the SMART or LINK grant in a wide diversity of technological fields including the following: impregnated paper for the blind; special solar panels; ceramics engineering; laser technology; siren signal technology; paper plant effluent control; human anatomy 3D modelling; high voltage switchgear; lifting devices for medical applications.

The interview guide was designed to focus on the areas of the firm's strategy and formulation process, its current strategy profile, experience of public supported R&D initiatives, details about the SMART or LINK project and additionality effects. A pilot interview guide was initially tested with colleagues and a company manager from a small local firm in order to obtain some initial feedback on the overall content of issues covered and timing matters, after which the pilot interview guide was revised. In order to obtain a sound understanding of the SMART or LINK grant 'project details', semi-structured interviews were conducted with a fairly open framework, which allowed for focused, conversational, two-way communication. This approach was useful and flexible, allowing both the interviewer and the person being interviewed the flexibility to probe for details or discuss issues. For example, when the issue of multiple and/or serial participation in government-funded initiatives emerged as important, some cases were contacted a second time to ascertain the extent of this phenomenon and to explore its significance.

Key findings

Based on the relatively small sample of companies interviewed there are a number of common issues arising that could be further tested with a larger statistically significant SME population through further research in this area of study. The most commonly cited impact was that the government R&D grant(s) enabled the firm to eventually commercialise the research either through the creation of a new product, or through the transfer of technology from the grant-funded project to other projects, or via the opening up of new niche market opportunities.

One of the main strategic findings was that firms involved in collaboration projects through LINK grants had indicated that they had acquired new knowledge from working closely with external collaborators. This is not just knowledge linked to the technical and operational aspects of the R&D project, but also knowledge about the external partner's key strengths and business competencies. This knowledge is strategically important because it is seen to add to the firm's existing stock of knowledge (Malik, 2004). This type of knowledge can be of vital importance in the future if the firm decides to approach the same external organisation regarding collaborating on a new project. This aspect of building external linkages and accumulating new knowledge is linked to the issue of the firm having confidence in its ability to move into more 'high risk' technological research areas (Howells, James and Malik, 2004). This might be research that can be undertaken for longer-term exploitation rather than for the shorter-term business requirements.

All the companies interviewed emphasised the importance of 'credibility' associated with winning a SMART or LINK grant. For smaller firms this is of crucial importance. Some managers mentioned that the publicity received by their firm after attending a SMART achievement award meeting gave them credibility, which was important in the

eyes of their customers and future collaborators. Linked to this issue is ‘networking’, which proved to be a key feature of the LINK award projects. It was stated that networking enabled the companies to interact with new contacts and again to acquire new knowledge from collaborating with external partners. Here the usefulness of building individual level contacts with people in other firms or university research centres was mentioned as an important component of networking. It was evident from these findings that one of the core rationales for public support, promotion of networking for SMEs, is of strategic importance here. This extends from building of contacts and external relationships through to full R&D co-operation with other companies, as well as universities and research institutes. These activities can result in the reduction of both the costs and uncertainty of the R&D project and of course facilitate access to complementary skills and capabilities.

Most companies interviewed stated that there was a strong link between receiving public R&D grant support from SMART and LINK awards and access to international niche markets. It appears that in today’s highly competitive and increasingly global business environment, technology-based SMEs must look to foreign markets early in their life cycles for opportunities to maximise their growth and profitability. This is creating urgency for companies to establish a position in key foreign markets even as they are starting-up and in an early growth stage. Hence, it appears that the traditional approach to delaying international expansion while building domestic market share is becoming less and less viable as a strategy in many technology sectors. Therefore making strategic use of public R&D support grants has the additionality effect of enabling international market expansion for smaller firms at an earlier stage than they would normally have contemplated doing so. The following selection of comments made by managers interviewed in the study help to illustrate this point further:

“The SMART awards have been fundamental to fuelling the growth of our company’s international market access.”

“R&D support received through SMART awards and other grants has enabled us to undertake R&D projects on a world level scale, but we have lacked the financial investments required to get into a number of key international markets.”

“One of the direct impacts of an earlier SMART award is that the company now has about 2 500 heating machines supplied all over the world for blind educational needs.”

“Our company operates in an industrial sector that is characterised by rapid international market movements in product taste, therefore companies need to be responsive to fast changing market needs.”

One of the most striking findings from this exploratory study has been the emergence of clear evidence that the evaluation of a grant as a ‘stand-alone’ activity does not represent a realistic approach when considering evaluation at the level of firm strategies. In most of cases the firms, despite their small size and usually relatively recent creation, had received a succession of R&D grants and other innovation-related support from government. This situation is not specific to the United Kingdom. A recent evaluation of the Finnish innovation support system found that firms typically used multiple grants and services and did not distribute their involvement over time according to any linear model of the innovation process (Georghiou *et al.*, 2003).

One of the few areas of concern mentioned by some firms was a problem relating to lack of support for commercialisation once the SMART award project has been completed. Here it was stated that marketing was key not only to the pre-R&D and production phase of an innovation project, but also key to the final phase in pre-commercialisation of an end product. According to Oakey (2003), this is seen as a point of financial ‘maximum stress’ for most firms. This juncture is often reached after a long period of R&D has exhausted the firm’s financial resources, when no income from sales has yet been achieved, and when a ‘ramping up’ of marketing spend is requested in order to make the new product a commercial success. As Oakey (2003) adds, seen in this light, the lack of SMART support for invention and innovation through this critical period of financial ‘maximum stress’ might be seen as a weakness of this public R&D support scheme, although Treaty of Rome restrictions on government support for marketing restricts the scope for potential financial assistance in this area.

Behavioural additionality effects

Some aspects of the findings concur with some earlier survey research findings from a study conducted by North *et al.* (2001) with SMART grant award holders in the London region. For example, it was confirmed that without the SMART grant, new businesses founded in the year that the SMART award was received would not have started without the grant. In the case of existing businesses, some projects would not have simply gone ahead without the help of the award.

Overall, the most important feature emerging from the behavioural additionality aspect of this exploratory study was the cumulative learning involved in projects. While the award of individual grants could be justified in terms of a continuing need for resources either for the further development of the same innovations or for R&D aimed at different products, the attribution of benefits was less easy to distinguish across projects. In particular, firms were insistent that even projects that had not led to exploitation nonetheless contributed towards capabilities that were exploited in the context of other projects. These capabilities included:

- Human resources: people recruited as a result of one grant were subsequently key contributors to later work.
- Technological knowledge and skills: enhancements during one grant were applied subsequently.
- Networking: partners and contacts acquired as a result of one grant formed the basis of subsequent collaborations.
- Reputational and prestige benefits accumulated through a track record of awards.
- External knowledge absorption: distinct from networking but often a consequence.
- Using public support: in the context of the critical role of public funding for R&D that was reported by these SMEs, it can be argued that an important dimension of learning is the ability initially to win, and then to sustain, public support through successive applications.
- Improved innovation management capabilities.

The networking and external knowledge absorption capabilities are of strategic concern to more and more companies now and this issue links to how private firms make use of public research as addressed in Cohen and Levinthal's (1990) absorptive capacity model. They argue that the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capability. Cohen and Levinthal (1990) label this capability a firm's 'absorptive capacity', and they suggest that it is largely a function of the firm's level of prior related knowledge. They formulate a model of firm investment in R&D, in which R&D contributes to a firm's absorptive capacity, which in turn, allows the firm to access external information in such a way as to maximise their R&D capabilities. The literature indicates that there are many potential knowledge advantages associated with networking and collaborative partnerships (Powell, Koput and Smith-Doerr, 1996; Matusik and Hill, 1998), including the potential value associated with pursuing a knowledge accumulation and creation strategy through collaborative partnerships.

For some smaller firms these types of public grants are not only vital for supporting an R&D project in the firm, but also help the firm to recruit new highly qualified staff to work in the area of research and development. For example, one firm reported that without these types of grants, the company would not have been in a position to have built up their R&D capability through recruiting R&D staff. Therefore the grant acted as the catalyst to initially recruit an engineer and this person was then able to move into other R&D-related activities inside the company after the grant aided project had been completed. An important secondary effect mentioned was that this type of new recruit can be an important asset to the firm's organisational learning process in terms of someone who is able to bring in new ideas from outside and act as a willing transmitter of knowledge with other colleagues inside in the firm. Some authors have described this type of person as an 'expert' individual in the organisation who has two key skills: first, the ability to create or interpret new ideas from outside sources, and second, the social skills to transmit the knowledge to others (March, 1991). Therefore synergies can be created as knowledge is integrated and reinterpreted by organisational members (Spender, 1994).

Improvements in a small firm's innovation management capabilities are seen as a valuable output from the experience gained with working on SMART or LINK award projects. In larger firms, deliberate organisational design and formal procedures are usually essential as a means of integrating knowledge, of supporting professional judgements and of getting things done. In smaller firms, the characteristics of the manager/founder or senior technology manager – their training, experience, responsibilities and external linkages – play a central role. In particular, their level of technical and organisational skills will determine whether or not they will be able to develop and commercially exploit a firm-specific technological advantage (Tidd, Bessant and Pavitt, 2001).

Conclusion

The evidence presented here, although from an exploratory study, supports the initial hypotheses that public support for R&D in companies affects firm strategies, largely in a positive direction, and hence that behavioural additionality is exhibited. Furthermore it has provided the strong suggestion that from a firm's perspective public support for R&D is seen as a package which extends both sequentially within successive grants from the same scheme and in parallel with other sources of support.

The complex ways in which impacts may occur are difficult to identify. Gathering evidence is similarly resource-intensive. Extensive face-to-face interviewing revealed many details that could not have come from paper-based questionnaire studies. However, further research may result in more systematic frameworks for use in identifying pathways of effects on behaviour of firms.

However, in what has been a very small exploratory study, there has not been the opportunity to assess the prevalence of behavioural additionality on a statistical basis. The survey sample consisted principally of small, technology-based firms and the results cannot be presumed to apply to the way in which larger firms are affected by participation.

It can be conjectured that the higher the proportion of R&D funding coming from public sources, the more likely a firm's behaviour is to be affected but evidence does not exist to date. It could equally be postulated that a clear benefit from change illustrated by a single intervention, or a series of them, could be recognised by the firm and embodied into its broader routines. It is also possible that certain behavioural traits, in any size of firm, could be specific to the situation of public funding and not penetrate to self-funded activities. This would suggest that a logical extension of this work would be a systematic comparison of the full behavioural context between publicly funded and self-funded R&D and innovation in the same firm.

Table 11.1. **LINK Programme: status in June 2005**

Electronics/Communications/IT	Food & Agriculture	Biosciences & Medical	Materials & Chemicals Programmes	Energy & Engineering
Open programmes Mobile Telecommunications and Health Research	Open programmes Sustainable Arable Programme Sustainable Livestock Production Advanced Food Manufacturing Food Quality and Safety Horticulture Earth Observation	Open programmes Health Technology Devices Programme	No open programmes	Open programmes Ocean Margins
Closed programmes E-Science GRID Technologies Information Storage and Displays Basic Technologies for Industrial Applications Sustainable Technologies Initiative LINK Programme People at the Centre of Communications And Information Technologies Optical systems Next Wave Technologies and Markets Advanced Sensors for Ocean Applications Broadcast Technology Sensors and Sensor Systems for Industrial Applications Management of Information for Fraud Control, Security and Privacy Molecular Electronics Advanced Semiconductor Materials Industrial Measurement Systems Personal Communications Phase I Personal Communications Phase II Optoelectronics Systems Design of High Speed Machinery Power Electronic Devices and Derived Systems Technology for Analytical and Physical Measurement High Performance Interfaces and Protocols Photonics	Closed programmes Sustainable Technologies Initiative Aquaculture Agro-Food Quality Technologies for Sustainable Farming Systems Crops for Industrial Use Food Processing Sciences Competitive Industrial Materials from Non-Food Crops Eating, Food and Health	Closed programmes Bioremediation Sustainable Technologies Initiative LINK Programme Applied Genomics Medical Technologies (MedLINK) Biological Treatment of Soil and Water Eukaryotic Genetic Engineering Biotransformations Selective Drug Delivery and Targeting Control of Plant Metabolism Molecular Sensors Medical Implants Protein Engineering Cell Engineering Biochemical Engineering Analytical Biotechnology Genetic and Environmental Interactions in Health Integrated Approaches to Healthy Ageing	Closed programmes Basic Technologies for Industrial Applications Sustainable Technologies Initiative Manufacturing Molecules Structural Composites New Catalysts and Catalytic Processes Enhanced Engineering Materials Asymmetric Synthesis Applied Catalysis and Catalytic Processes Applied Biocatalysis	Closed programmes Foresight Vehicle Basic Technologies for Industrial Applications Sustainable Technologies Initiative Meeting Client's Needs through Standardisation in the Construction Industry Future Integrated Transport Integration in Design and Construction Waste Minimisation through Recycling, Re-use and Recovery in Industry Inland Surface Transport Surface Engineering Hydrocarbon Reservoirs Nanotechnology Ventilation, Air Conditioning and Refrigeration Transport Infrastructure and Operations Enabling Technologies for Advanced Rotorcraft Construction Maintenance and Refurbishment Oil and Gas Extraction

Source: DTI, revised by authors.

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Chapter 12

BEHAVIOURAL ADDITIONALITY OF THE US ADVANCED TECHNOLOGY PROGRAMME

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Abstract. The goal of public-private partnerships such as the Advanced Technology Programme (ATP) is to fund projects that have the potential for large social and economic benefits beyond those earned by the companies participating in these projects. One aspect of these benefits includes how the behaviour of firms changes as a result of receiving an ATP award. Findings from the Survey of ATP Joint Ventures are presented to understand these behavioural factors such as willingness to undertake high-risk research, trust, and collaboration, as well as why joint ventures form and what factors contribute to the success of joint ventures. ATP involvement is important in helping to foster trust and co-operation among joint venture partners as well as to ensure stability of funding and commitment to the project. ATP joint venture projects are more ambitious than other R&D initiatives in the industry, involve new directions for the company and industry, have more technical risk than typical R&D projects, have a longer expected time to initial return on investment, and are technically more difficult than typical R&D projects at the respondent's company.

Introduction

The Advanced Technology Programme (ATP) is a public-private partnership programme sponsored by the US Department of Commerce at the National Institute of Standards and Technology. The ATP supports high-risk technology innovation through competitive funding of awards to for-profit companies. ATP funds both single applicant and joint venture projects¹. The findings presented in this chapter use results from the Survey of ATP Joint Ventures. The focus is on understanding why joint ventures form and what factors contribute to the success of joint ventures, including behavioural factors such as willingness to undertake high-risk research, trust, and collaboration. About one-third of ATP projects are joint ventures and they receive about two-thirds of ATP funding. To encourage companies to form joint ventures, ATP awards to joint ventures are for larger amounts of money and for a longer time frame than are awards made to single-applicant companies.

1. ATP joint ventures are research joint ventures (RJVs). RJV is the term used in the economic literature.

ATP's mission is *to accelerate the development of innovative technologies for broad national benefit through partnerships with the private sector*. As the mission notes, ATP funds projects that have the potential to produce broad national benefits; these are projects that will provide benefits to the economy and society. Examples include the development of high-energy imaging technology, surgical repair of cartilage and tendons, a new generation of digital mammography, and speech recognition software to help computer novices and the severely disabled communicate. ATP supports the nation's energy security through investments in breakthrough technologies for fuel cells, solar cells and batteries. ATP funded several projects to support the development of diagnostic tools used to isolate and evaluate genetic information.

One measure of broad national benefit is the effect of receiving an ATP award on the company and project participants' behaviour during the project and after the project ends. The genesis of the Survey of ATP Joint Ventures builds primarily on work by Dyer and Powell (2001) who studied joint ventures in the automotive sector. In 1999, they conducted semi-structured interviews of ATP project managers and company representatives from 18 joint venture projects initiated between 1991 and 1997. Dyer and Powell found that factors that increase trust and knowledge sharing and that reduce co-ordination costs improve success rates for joint ventures. The ATP process, from preparing the proposal to managing the project, including preparation of quarterly technical and business reports and regular visits by ATP project teams, helps ATP joint ventures overcome barriers to collaboration and helps collaborative projects to run more smoothly, although with some loss of flexibility. The findings from this initial study were used as one of the inputs to design the Survey of ATP Joint Ventures conducted in 2003. The other inputs were questions and data from ongoing surveys of ATP-funded companies as well as research hypotheses of interest to ATP.

The Advanced Technology Programme

The Advanced Technology Programme is a partnership between government and private industry to conduct high-risk research to develop enabling technologies that promise significant commercial payoffs and widespread benefits for the economy. ATP provides a mechanism for industry to extend its technological reach and push the envelope beyond what it otherwise would attempt. ATP funds:

- Enabling technologies that are essential to the development of future new and substantially improved projects, processes, and services across diverse application areas;
- Technologies for which there are challenging technical issues standing in the way of success;
- Technologies whose development often involves complex “systems” problems requiring a collaborative effort by multiple organisations; and/or
- Technologies that will go undeveloped and/or proceed too slowly to be competitive in global markets without ATP.

ATP funds technical research, but not product development. ATP is industry-driven—that is, for-profit companies conceive, propose, co-fund, and execute all of the projects cost-shared by ATP; these projects often include work by universities and other non-profit organisations.

Smaller firms working on single-company projects pay a minimum of all the indirect costs associated with the project. Fortune 500 companies participating in single-company projects must pay at least 60% of total project costs. Participants in joint venture projects pay at least half of total project costs. Single-company projects can last up to three years and receive an award for up to USD 2 million over three years to cover project costs; joint venture projects can last as long as five years. Companies of all sizes participate in ATP-funded projects. To date, nearly two out of three ATP awards have gone to individual small businesses or to joint ventures led by a small business.

At least two separately owned for-profit companies may apply as a joint venture, with both companies substantially contributing to the research effort and to the requirement to cover at least half of the total project costs. Additional organisations (universities, non-profits, or other companies) may join the joint venture either as formal participants or as subcontractors. Joint ventures may receive ATP funding for up to five years, with no funding limitation other than the announced availability of funds and the organisations' ability to cover half the total project costs. One-third are joint venture projects, and they receive two-thirds of ATP funding.

ATP announces competitions through the *Federal Register* and has held 44 competitions between 1990 and September 2004. ATP has provided USD 2.2 billion in awards, and industry has matched an additional USD 2.1 billion as cost share, for a total of USD 4.3 billion for high-risk research. Of the 768 projects awarded to date, 550 involve single-company applicants and 218 involve joint ventures. More than 165 universities and 30 national laboratories participate in ATP projects, reflecting the collaborative nature and the diversity of the projects' participants. Projects are organised into four broad technology areas: advanced materials and chemistry, information technology, electronics and photonics, and biotechnology. Manufacturing is a subset in all four categories. Technical topics under each of the broad categories are broad and diverse.

Each project has specific goals, funding allocations, and completion dates established at the outset. Projects are monitored and can be terminated for cause before completion. All projects are selected in rigorous competitions that use peer review to identify those that score highest against technical and economic criteria.

Survey of ATP Joint Ventures

This chapter focuses on describing characteristics of joint venture projects, presenting measures of outcomes, and identifying characteristics that increase or decrease the likelihood of project success, including short- and long-term changes in behaviour. Improved understanding of the factors that contribute to success enhances the evaluation of how joint venture projects are selected for award, how they are managed, and how their success is measured and quantified.

Joint ventures have unique characteristics and may differ from single company projects in a number of important ways. Beginning in the spring of 2003, ATP conducted a survey of all companies and non-profit organisations that embarked on an ATP-funded joint venture project between 1991 and 2001. The *Survey of ATP Joint Ventures* explores the characteristics of joint ventures and factors that lead to project success.

Survey development and data collection

ATP contracted with Westat, a survey research firm, to assist with survey development, implementation and administration. ATP provided Westat with draft questions that were based partly on prior surveys of ATP-funded companies and partly on research hypotheses of interest to ATP. Two versions of the survey were developed: one for companies and one for non-profit organisations.²

The survey used a mixed-mode methodology that included an Internet survey and a follow-up phone interview for those that did not respond to the online survey. Attempts to follow up with non-respondents via telephone survey typically resulted in the respondent's completing the Web survey rather than participating in a telephone interview.

Data were collected from 1 May 2003 through 15 November 2003. Following standard survey procedures, multiple contact attempts were made in order to maximise survey response rates. Advance letters describing the purpose of the survey were mailed to company contact persons associated with each ATP joint venture project. One week later, e-mail letters reiterating the survey's purpose and providing login information were sent to these same contact persons. Three reminder e-mails were sent to non-respondents over the course of several weeks. After eight weeks, Westat began contacting non-respondents by telephone to collect the survey data.

Survey co-operation rates and comparisons by participant characteristics

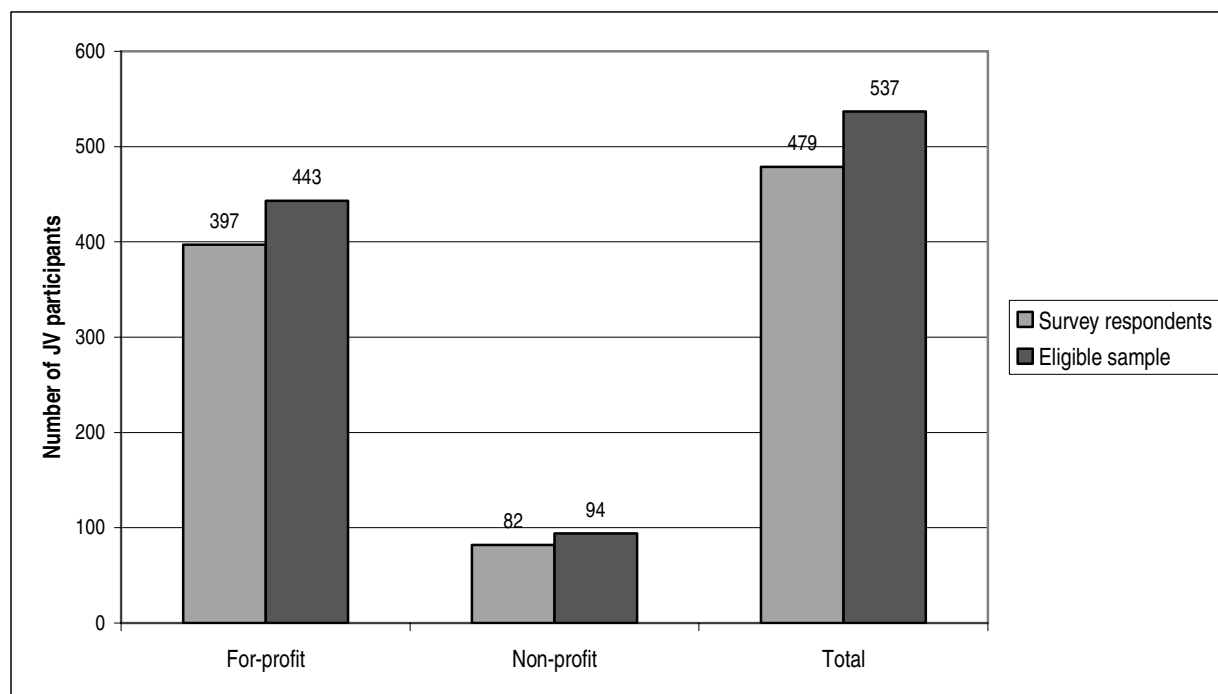
All companies and non-profit organisations that embarked on an ATP-funded joint venture project between 1991 and 2001, and for whom a respondent could be located, were included in the sample. Initially, 591 companies and organisations were identified as potential participants in the survey sample. As work on the survey progressed, 54 of these were removed from the pool as it became clear that there was no knowledgeable respondent available due to business closings, staff turnover, or aborted projects. This resulted in a total of 537 eligible respondents representing 142 projects³. Thus, the overall response rate was 81% (479 responding participants/591 participants in the survey sample).

Of the 537 for-profit companies and non-profit organisations eligible to respond, a total of 479 surveys were completed⁴, for an overall co-operation rate of 89% (479 responding participants/591 participants in the sample less 54 removed from the pool). Among 443 eligible for-profit companies, 397 responses were received (including 10 by telephone) yielding a co-operation rate of 90%. These 397 respondents represented all 142 projects funded by ATP during this period. Of the 94 eligible non-profit organisations, 82 responses were received (including 4 by telephone) yielding a co-operation rate of 87%. The 94 respondents from non-profit organisations represented 50 joint venture projects (see Figure 12.1).

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2. Given the similarity of the two surveys, they are referred to as a single survey throughout this chapter.
 3. ATP awards are not restricted to those who have never received ATP funding. Thus, one individual might be the contact person for two or more ATP-funded projects. It is therefore possible that the same individual completed multiple Joint Venture Surveys for multiple projects. We cannot calculate the number of times this might have happened as we did not gather data on the specific identity of the respondent.
 4. It was possible that no eligible member of a particular joint venture would respond to the survey. This possibility, however, did not occur. Thus, the 537 eligible respondents as well as the 479 *actual* respondents both represented 142 joint venture projects.

Figure 12.1. Number of JV survey participants (start years 1991-2001)

Eligible sample and survey respondents



If respondents from companies and organisations that completed the survey differ in some way from those that did not respond, these differences might create biased survey results. To evaluate the possibility of non-response bias, response rates were compared by: company size; project age; technology area; amount of project award; joint venture size; and project duration.

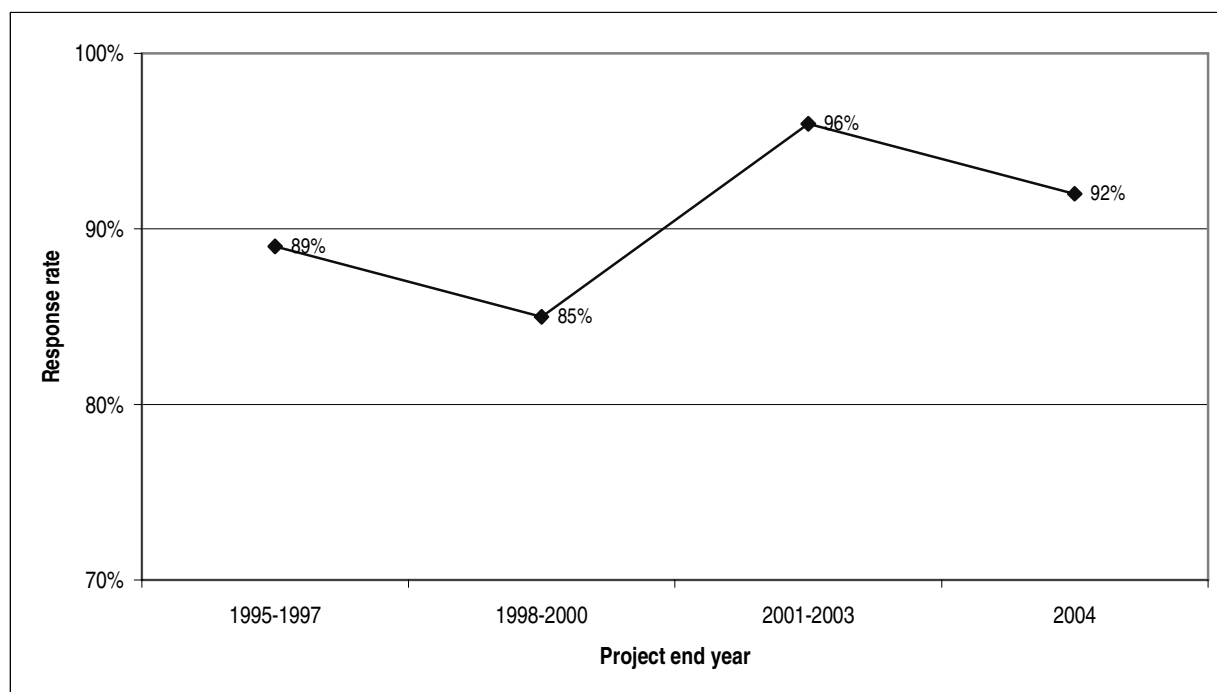
Statistical testing on the co-operation rate differences in each of the above comparisons revealed few significant differences. This suggests that there is little non-response bias in the survey, at least with respect to these characteristics.

Company size. Co-operation rates are similar across companies regardless of company size. The range is from 87% for medium-size companies to 90% for small companies and 91% for large companies.⁵

Project age. Company partners on more recently concluded projects (2001 to 2003) were more likely to respond. Respondents associated with joint venture projects that ended in 1995-1997 or 1998-2000 were less likely to complete the survey, as were respondents whose projects ended in 2001 to 2003 (89% and 85% vs. 96%, respectively). Respondents who represented projects that were due to end in 2004 were equally likely to respond to the survey as those whose projects ended in 1995-2000 (see Figure 12.2).

5. The “Fortune 500” companies are the top 500 companies in revenue, with approximately USD 3 billion in revenue, the year that ATP funding was awarded. For purposes of this chapter, large companies are all “Fortune 500” companies, small companies are those with fewer than 500 employees, and all other companies were placed in the “medium” category.

Figure 12.2. Response rates by joint venture project end year



Technology area. Co-operation rates were similar across project technology areas. Statistical testing on the differences across technology area revealed no significant differences, suggesting non-response bias does not vary by the project's technology area (see Table 12.1).

Table 12.1. Co-operation rates by joint venture project, by technology area

Technology area	Co-operation rate
Chemistry & Materials	89%
Biotechnology	87%
Electronics & Photonics	90%
Information Technology	86%
Manufacturing	90%

Amount of project award. Co-operation rates showed little variation across different categories of ATP award size. The observed co-operation rates vary by less than 6%, which suggests that the amount of the ATP award had little bearing on a respondent's willingness to complete the survey. The co-operation rates varied from 87% for joint venture projects that received an award of over USD 8 million to 92% for those projects that received USD 3 to 5 million (see Table 12.2).

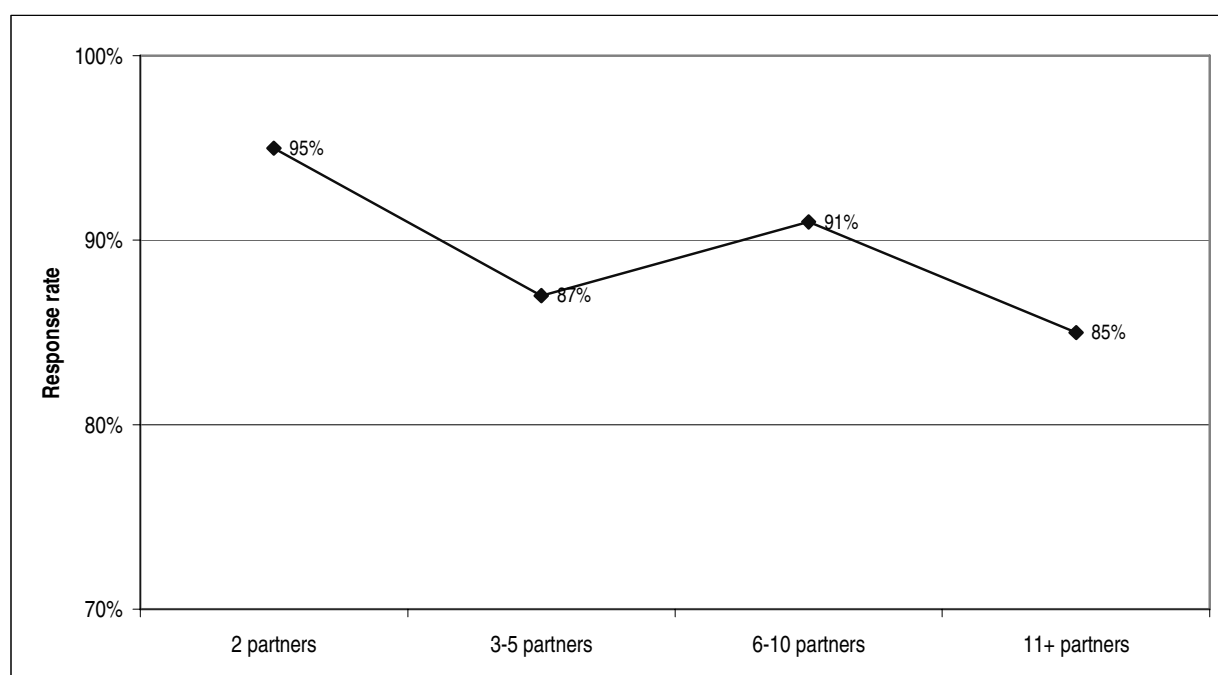
Table 12.2. Co-operation rates by amount of ATP award

Amount of ATP award	Co-operation rate
3 million and less	91%
Over 3 million to 5 million	92%
Over 5 million to 8 million	88%
Over 8 million and up	87%

Joint venture size. The average size of a joint venture ranged from 3.2 partners for biotechnology projects to 7.6 partners for manufacturing projects. Among information technology and biotechnology projects, about one in ten is a joint venture; this differs from the other three sectors (chemistry and materials, electronics and photonics, and manufacturing), in which about one in three ATP projects is a joint venture. Interestingly, when the IT sector does form a joint venture, it tends to be large, with on average six members.

Company partners in smaller joint ventures were more likely to respond. A sense of diffusion of responsibility might affect the willingness of members of larger joint ventures to complete the survey; each assuming that another member of the joint venture would do it. Co-operation rates, when examined by joint venture size, show some support for this general pattern. Respondents associated with larger joint venture projects, in general, were less likely to complete the survey than respondents associated with smaller joint venture projects. Respondents from joint ventures with two partners were significantly more likely to complete the survey than respondents from joint ventures with three to five partners or with 11 or more partners. Statistical testing on the four remaining possible comparisons showed no significant differences (see Figure 12.3).

Figure 12.3. Response rates by joint venture project size



Project duration.: Co-operation rates varied little by project duration. Statistical testing on the differences in project duration, measured in years, revealed no significant differences, which suggests that respondents were equally willing to complete the survey regardless of project duration.

Assessing behavioural additionality in ATP

What are the motivations for forming a joint venture?

The ATP proposal and award process leads to the creation of new research collaborations that would not otherwise occur. These collaborations occur among for-profit companies, universities, national labs, and contractors. The most frequently cited motivation for forming a joint venture is the benefits from complementary R&D expertise of other firms (see Table 12.3).

More than four out of five respondents said that benefiting from complementary R&D expertise and the capabilities of different firms was an important reason to partner with other companies to implement the ATP-funded project⁶.

Nearly three-quarters of the respondents indicated that pooling resources with other firms and addressing a technical problem in their industries were important reasons in their company's decision to partner with other firms.

Two out of five respondents reported that forming a joint venture to access commercialisation capabilities of other firms was an important reason to form a joint venture.

Table 12.3. **Motivations for forming a joint venture**

Motivations for forming a joint venture	Percent
Benefit from complementary R&D expertise	83%
Pool resources with other firms	72%
Address a technical problem that is common to the industry	72%
Gain knowledge and learn from other firms	66%
Access commercialisation capabilities of other firms	42%

How likely is it that the joint venture would have formed without ATP support?

Across joint ventures of varying sizes, respondents consistently reported that it was unlikely that the joint venture would have formed without ATP support (see Table 12.4).

Respondents representing joint ventures of different sizes did not differ in their perceptions of the likelihood that the joint venture would have formed without ATP support.

More than nine out of ten respondents with three or more partners in their joint ventures indicated that it was not likely that the joint venture would have formed without support from ATP.

6. The response categories “extremely important” and “very important” are combined for ease of reporting.

Table 12.4. **Percentage of respondents who indicated that without ATP support the joint venture is not likely to have formed**

By size of joint venture

Joint venture size	Percent
All respondents	93%
2 partners	88%
3 to 5 partners	93%
6 to 10 partners	95%
11+ partners	94%

How important is ATP support for ensuring stability of company funding and commitment to the project?

Respondents from small companies were more likely than those representing large- and medium-sized companies to view ATP support as important for ensuring stability of funding and commitment to the joint venture project (see Table 12.5).

Because R&D dollars in large- and medium-sized firms are tight and because there are entrepreneurs in these firms, ATP support is also important for ensuring company stability and commitment to the joint venture project in these companies (see Table 12.5).

Table 12.5. **Percentage of respondents indicating that ATP support ensures stability of company funding and commitment to the project**

By company size⁷

Size of JV company lead	Percent
All respondents	80%
Small	87%
Medium	71%
Large	79%

How important is ATP involvement in helping to foster trust and co-operation among joint venture partners?

Across joint ventures of varying sizes, and by technology area, respondents representing joint ventures of different sizes consistently reported that ATP involvement was important in helping to foster trust and co-operation among joint venture partners.

Almost two out of three respondents reported that they perceived that ATP involvement fosters trust and co-operation among joint venture partners (see Table 12.6).

Regardless of technology area, respondents consistently viewed ATP involvement as important in helping to foster trust and co-operation among joint venture partners (see Table 12.7).

7. ATP defines small companies as those with fewer than 500 employees, large companies as those belonging to the Fortune 500 at the time of award, and medium companies as all others.

Table 12.6. **Percentage of respondents who indicated that ATP involvement fosters trust and co-operation among joint venture partners**

By size of joint venture

Joint venture size	Percent
All respondents	64%
2 partners	63%
3 to 5 partners	60%
6 to 10 partners	72%
11+ partners	61%

Table 12.7. **Percentage of respondents who indicated that ATP involvement fosters trust and co-operation among joint venture partners**

By technology area

Technology area	Percent
Electronics & Photonics	71%
Information Technology	66%
Manufacturing	63%
Chemistry & Materials	63%
Biotechnology	48%

Do the joint venture projects represent new R&D directions for companies and for industry?

More than three-quarters of respondents indicated that their ATP joint venture project represents a new R&D direction for both their company and respective industries.

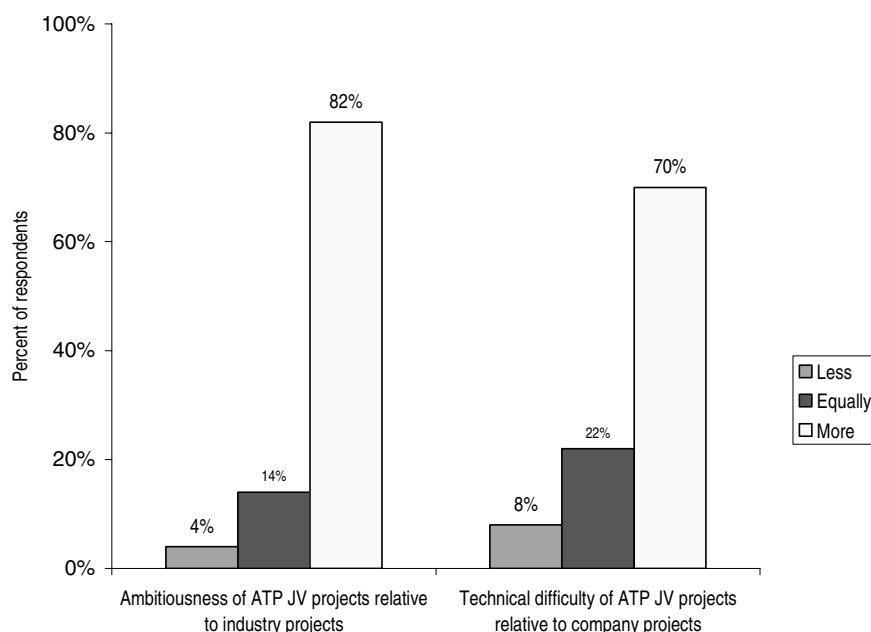
Are ATP-funded joint venture projects more ambitious than other R&D initiatives in their industry?

More than eight in ten respondents stated that their ATP joint venture projects were more ambitious relative to other R&D initiatives in their industry (see Figure 12.4).

Are ATP joint ventures more technically difficult than typical R&D projects at their company?

Seven in ten respondents stated that their ATP joint venture projects were more technically difficult relative to other R&D projects in their company (see Figure 12.4).

Figure 12.4. **Percentage of respondents who indicated that the ATP joint venture project is less, equally, or more ambitious and technically difficult relative to other R&D projects**



How does the technical difficulty of the company's part of the ATP joint venture compare with the typical R&D project at their company?

ATP-funded joint venture projects have more technical risk than typical R&D projects at the company. On average, the respondents to the survey estimated the probability of fully achieving the technical goals of the ATP joint venture project at 55% as compared with 68% for typical R&D projects at the company.

How many years after the start of the ATP joint venture does the company expect results to first have an impact on company revenue compared with a typical R&D project at the company?

ATP-funded joint venture projects have longer time horizons for realising revenue and/or cost savings than do typical R&D projects at the company. On average, the respondents to the ATP Joint Venture Survey estimated the number of years until the results of the ATP joint venture project could first have an impact on company revenue or costs at six years as compared with four years for typical R&D projects at the company.

Summary

Descriptive results from ATP's survey of joint ventures show that companies form an ATP joint venture to benefit from complementary R&D expertise, to pool resources with other firms, and to address a technical problem that is common to an industry. An ATP award ensures stability of company funding and commitment and fosters trust and co-operation among partners. The survey results further demonstrate that ATP-funded projects:

- Are more ambitious than other R&D initiatives in the industry;
- Are technically more difficult relative to typical R&D projects at the respondent's company;
- Take on projects that involve new directions for the company and industry;
- Have more technical risk than typical R&D projects at the respondent's company; and
- Have a longer expected time to initial return on investment than do typical R&D projects at the respondent's company.

There are additional results from the survey of ATP joint ventures that focus on information about knowledge sharing, university involvement, and other topics that would inform studies of behavioural additionality.

Findings from other studies

In this section, findings from other studies that use the Survey of ATP Joint Ventures data are presented. These other studies focus on what factors contribute to the success of the joint venture and other perceptual measures of value to the firm as a result of participation in an ATP-funded joint venture, controlling for the characteristics of the joint ventures. Dyer *et al* (2005) used the Survey of ATP Joint Ventures to examine the determinants of success in R&D alliances. They used three measures of success in the analysis of R&D alliances: perceptual measures of success (whether the alliance succeeded in achieving its objectives), patent counts, and financial measures (dollar value derived from innovations developed in the alliance). Their key findings are:

Governance and contractual provisions. Effective agreements that protect intellectual property and help prevent disputes are more important than goodwill trust in influencing alliance success.

Frequency of interaction. Frequent face-to-face or other interaction among alliance participants has a positive effect on R&D alliance success.

Number of participants. As the number of participants increases, so do the transaction and co-ordination costs associated with managing the alliance. There is a trade-off in determining the optimal number of alliance participants; it's essential to recognise that while new firms bring additional resources, there are increased costs associated with adding new participants.

Prior partner-specific experience. Prior partner-specific experience has a positive effect on performance outcomes, as indicated by perceptual measures of success.

Collaboration with direct competitors. Performance outcomes, as indicated by perceptual measures of success and patents, are lower in R&D alliances that involve competitors.

In a similar fashion, Campbell and Wang (2004) examine what factors contribute to positive outcomes for the company (commercialisation, perceived overall value to the company, and perceived intangible value). Their analysis found that projects are more likely to have positive outcomes when projects have greater technical risk; are more ambitious; represent new R&D directions; involve greater university interaction; involve greater knowledge sharing, *i.e.* project partners are more likely to indicate positive

perceived overall and intangible value; and include joint venture member companies who have greater previous experience with R&D collaboration in general.

Strengths/weaknesses of the methodology and future work

Strengths and weaknesses of survey methodology

The analysis presented in this paper is based on survey data. Surveys are useful for collecting detailed data that provide descriptive statistics and are useful for modelling results. The reliability of self-reported data is always an issue, as respondents may give the answers they think they should. This is referred to as “socially desirable” reporting; they may not answer truthfully, or they may simply not know the answer. Also, the Survey of ATP Joint Ventures collects data from government-sponsored joint ventures in the United States. It may or may not be possible to generalise the results to joint ventures that do not have government support, as well as to joint ventures in different settings. Future work may look at comparing results from non-government funded joint ventures.

Ongoing and future work

The Advanced Technology Programme’s multifaceted evaluation programme allows us to study behavioural additionality from many dimensions. Findings from the Survey of ATP Joint Ventures can be enhanced by tracking companies into the post-project period and using results from the ATP Post-Project Survey, status reports (mini-case studies), and in-depth case studies on selected projects and examining whether a company’s change in behaviour remains after a project ends.

ATP’s post-project survey conducts interviews with companies at two, four, and six-year intervals. Findings from a post-project survey at two years after an ATP project ends show that 83% of companies continued co-operative technology and more than half (55%) of those who continued said it was due to the positive impact of their ATP experience. *Working on their ATP technology*, ATP companies continued to collaborate with new partners (27%), including collaborations with their joint venture partners (19%), and with their subcontractors (31%). *Working on their non-ATP technology*, almost half of companies that participated in an ATP joint venture continued to work with their joint venture partners and 14% continued to work with their ATP subcontractors.

ATP’s Business Reporting System (BRS) allows for a longitudinal tracking of companies (see Anderson *et al.*, 2003 for a description of the BRS). This is a new area that will be undertaken once an integrated database is created to facilitate analysis across time. The BRS also allows for comparisons across types of projects, for example behavioural additionality for small, medium, and large firms. This analysis will build on existing work that studies ATP projects by firm size (Anderson, 2004).

Case studies add richness to survey data and statistics. They help to improve understanding of the effects of an ATP award to a company. A mini-case study or status report is written about each project several years later. The purpose of the status report is to assess whether commercialisation of the technology has occurred. Currently, there are close to 150 status reports on the ATP Web site⁸. This site allows a user to search for status reports by characteristic, such as whether the project is a joint venture or single applicant, or by company size. In addition, the ATP’s Economic Assessment Office has commissioned several cost-benefit studies on promising ATP technologies. Future work

8. http://statusreports-atp.nist.gov/basic_form.asp

may also examine the longer-term impacts of an ATP award on research productivity of the firm, in manner similar to Darby *et al* (2002) and Sakakibara and Branstetter (2002).

Conclusions

Descriptive results from the survey of ATP joint ventures show that companies form an ATP joint venture to benefit from complementary R&D expertise, to pool resources with other firms, and to address a technical problem that is common to an industry. ATP awards ensure stability of company funding and commitment and foster trust and co-operation among partners. The survey results also find that ATP-funded projects are more ambitious than other R&D initiatives in the industry, are technically more difficult relative to typical R&D projects at the respondent's company, have more technical risk than typical R&D projects at the respondent's company, and have a longer expected time to initial return on investment than do typical R&D projects at the respondent's company.

The concept of behavioural additionality provides another dimension for evaluating outcomes from ATP-funded projects. Behavioural additionality broadens the concept of success to include both the direct and indirect effects of government funding of high-risk projects. So even if a project is not technically or commercially successful, there may still be persistent positive effects that result. These projects create knowledge and this knowledge allows scientists and other personnel in companies to benefit and learn. Capturing this knowledge creation and change in behaviour and whether these changes persist is important for understanding the impact of ATP-funded projects.

Participating in the OECD workshops on behavioural additionality has provided ATP with new insights and approaches to its work and is especially timely as it is in the midst of improving the surveys. Including new questions that relate to behavioural additionality will enhance and inform the future work.

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Chapter 13

BEHAVIOURAL ADDITIONALITY OF THE EU'S 5TH FRAMEWORK PROGRAMME

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Abstract. The European Union's Framework Programmes for Research and Technological Development (FPs) are an important instrument of the European Commission not only for funding European-wide R&D projects, but also for helping organisations -- varying from higher research institutes and universities to large and even small and medium-sized enterprises -- to enter into or continue research. This chapter illustrates some of the results of the impact assessment exercise that was carried out in 2004 among participating organisations as well as rejected applicants with respect to the EU's 5th FP (FP5) relating to the notion of additionality.¹ More specifically, around half of the participating organisations stated that they would have abandoned their projects if they had not received FP5 funding whereas 70% of them considered the project(s) to be of great strategic importance for their organisation. One in three participating organisations stated that not receiving FP5 funding would have affected the way in which they would elaborate their project (behavioural additionality) while more than half of those who did actually carry out their projects after their proposal for funding was rejected, stated that the way they carried out their project was not the same as it would have been using FP5 funding. In general, FP5 helped participants to increase networking, which is crucial for carrying out R&D projects as organisations cannot afford to retain all necessary knowledge in-house. FP funding can have a significant impact on organisations in terms of actually carrying out their projects, but when organisations decided to carry out projects that were rejected for FP funding, this had little significant impact on the actual process of elaborating the project. It should be noted that FP5 projects usually formed a small fraction of the total R&D portfolio of organisations and thus the results should be interpreted with this in mind.

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Introduction

The EU Framework Programmes (FP) for Research and Technological Development are the main instrument through which the EU implements its research, science and technology policies. They were introduced in 1984 and originally were conceived as research support mechanisms promoting scientific excellence and the competitiveness of European industry. By the time of the fifth framework programme (FP5, 1999-2003), FPs had evolved into a more sophisticated set of instruments providing support for research geared towards the attainment of a broader set of socio-economic objectives. In turn, this expansion of objectives provided a platform for the development of the European Research Area, which was proposed as a major objective of EU research policy in 2000.

This chapter presents part of the results of a questionnaire survey carried out in 2004 for the assessment of the EU's 5th Framework Programme for Research and Technological Development (FP5)² that relate to the issue of additionality. Around 12 000 questionnaires were distributed to participants in FP5³ and almost 1 700 responses were gathered. The questionnaire used for this survey was divided into two sections: the first investigated the impacts that the projects undertaken had on the participating organisations, while the second part examined the specific impacts of the projects on the researchers as well as the organisations. Apart from the main questionnaire survey addressed to the participating organisations, another survey was carried out among a smaller number of applicants whose proposals were rejected for FP5 funding in order to identify what they actually did with their rejected proposals and further inform the issue of additionality.

Methodology

The concept of additionality was investigated along the following lines:

- *Total/project/pure additionality* stands for “the external funds that make it possible for work to be done which would not have been done otherwise”. From the firm's point of view, the project is purely additional to its original activities. In order to calculate pure additionality, the responses given by FP5 participants to the hypothetical question of “what would you do if you had not received FP5 funding” were juxtaposed with the answers provided by the applicants whose proposals were rejected for FP5 funding as to what they actually did with their projects. In addition, the possibility of abandoning the project if EU funds were not received was examined against characteristics of the projects themselves (cost, time scale, partners, etc.), the type of organisation, and the strategic importance of the potentially or actually abandoned projects.
- *Partial/behavioural additionality* is defined by Georghiou and Clarysse (2004) as the “the difference in firm behaviour resulting from the intervention”.⁴ Again, responses to the main questionnaire survey and the rejected applicants' survey

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2. EC, European Commission (2005) “Framework Programme 5 (FP5) Impact Assessment: A survey conducted as part of the five-year assessment of European Union research activities (1993-2003)”, further information and full report at: http://www.europa.eu.int/comm/research/reports/2004/fya_en.html, last accessed April 2006.
 3. IST participants were not included in this assessment exercise because a similar exercise was carried out in the Mobile, Micro and Health related fields.
 4. See Georghiou, 2004

were juxtaposed with respect to the questions referring to the aspects of project elaboration that would have changed or did change as a result of possible/actual rejection for FP5 funding. Further statistical analyses were conducted in order to examine the strategic importance of the projects that would have been/were carried out as well as the change in behaviour that would/did occur with respect to the project's characteristics due to the possibility/non-receipt of EU funding. In addition, within the notion of behavioural additionality, further aspects were addressed:

- *Acceleration additionality*, which was defined in the OECD workshop held in May 2004 in Manchester as “how did funding affect the speed with which R&D was performed?”⁵, and by R&D it was meant the R&D project carried out by the interviewees.
- *Scope additionality*, defined in the aforementioned workshop as the way with which subsidies can help R&D projects “to be extended to a wider range of applications, markets and partners”. Scope additionality was captured by asking the participants to indicate whether, within the course of their FP5 projects, they had collaborated with partners known from previous FP projects and/or with new ones.
- *No additionality*⁶ was measured by all participants who stated that they would not/did not change anything in their project elaboration without FP5 funding.
- *Negative additionality*⁷ was based on those participants that stated that without FP5 funding they would have done/did do at least one thing “better” in terms of the duration of the project, the scale, the scope and the benefits expected.

Apart from the statistical analyses that juxtaposed the responses to 1) hypothetical questions in the main questionnaire about what an organisation would do with the project without external funding with 2) the results of the survey of rejected applicants, further analyses were conducted in order to explore how participation in previous Framework Programmes has changed the R&D performance and R&D capability building of organisations. To this end, analyses were performed with respect to the effect of ‘project chains’, *i.e.* past experience in the elaboration of R&D projects – conducted in-house or through funding by national or European programmes or in new areas – on the intention of organisations to continue to conduct R&D projects in the future and with respect to the ways in which FPs help organisations improve their capabilities and skills (‘R&D capabilities building’). These further analyses assisted the research team in identifying how the FPs affected the participating organisations in terms of improvement and enhancement of their R&D aspects.

However, at this point it should be noted that FP5 projects usually formed a small fraction of the total R&D portfolio of organisations and thus the results should be interpreted with this in mind.

5. <http://www.oecd.org/dataoecd/54/10/34509750.pdf>

6. Ibid.

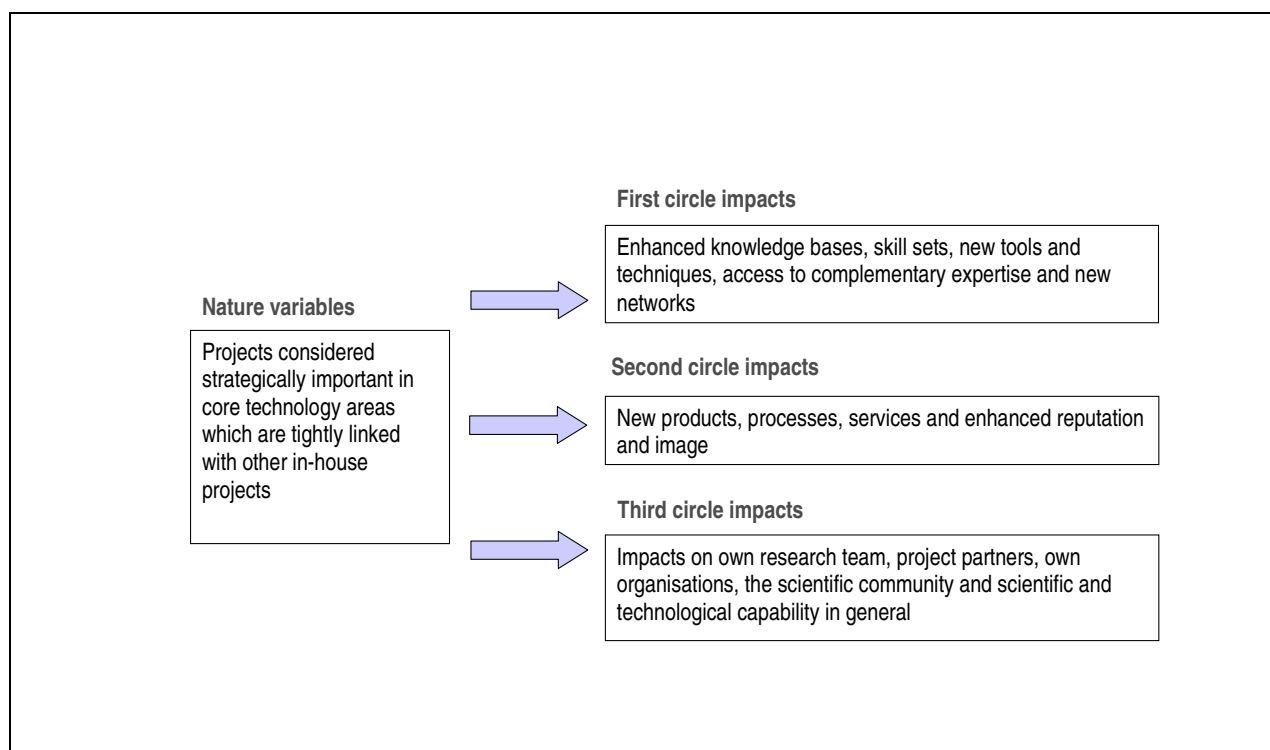
7. Ibid.

Description of the participating organisations

A rich mixture of stakeholders received funding under FP5: universities (29%) and research institutes (25%), industrial organisations varying from SMEs (30%) to large firms (9%), and a number of other types of organisations (7%). Many of these organisations had collaborated with each other previously (*i.e.* in previous FPs), but FP5 also allowed participants to extend their existing networks and form new partnerships.

One of the main conclusions of the analysis was that the most ‘successful’ projects were considered to be of high strategic importance, tightly linked to other in-house projects in the organisations’ core technology areas. These were positively associated with a range of impacts on the research teams that elaborated them, on the participating organisations and on the communities that would actually use the results of the projects (varying from the research team itself to sectors, standards and regulatory bodies). In more detail, these projects helped the research teams to enhance their knowledge bases and skill sets, to create new tools and techniques, to gain access to complementary expertise and to form new networks (first circle impacts). The participating organisations managed to create new products, processes and/or services and enhance their reputation and image (second circle impacts), and in general the projects bearing these characteristics had strong impacts on the research teams and their organisations, on project partners, on the scientific community and on the scientific and technological capability in general (see Figure 13.1).

Figure 13.1. Significant relationships: nature variables



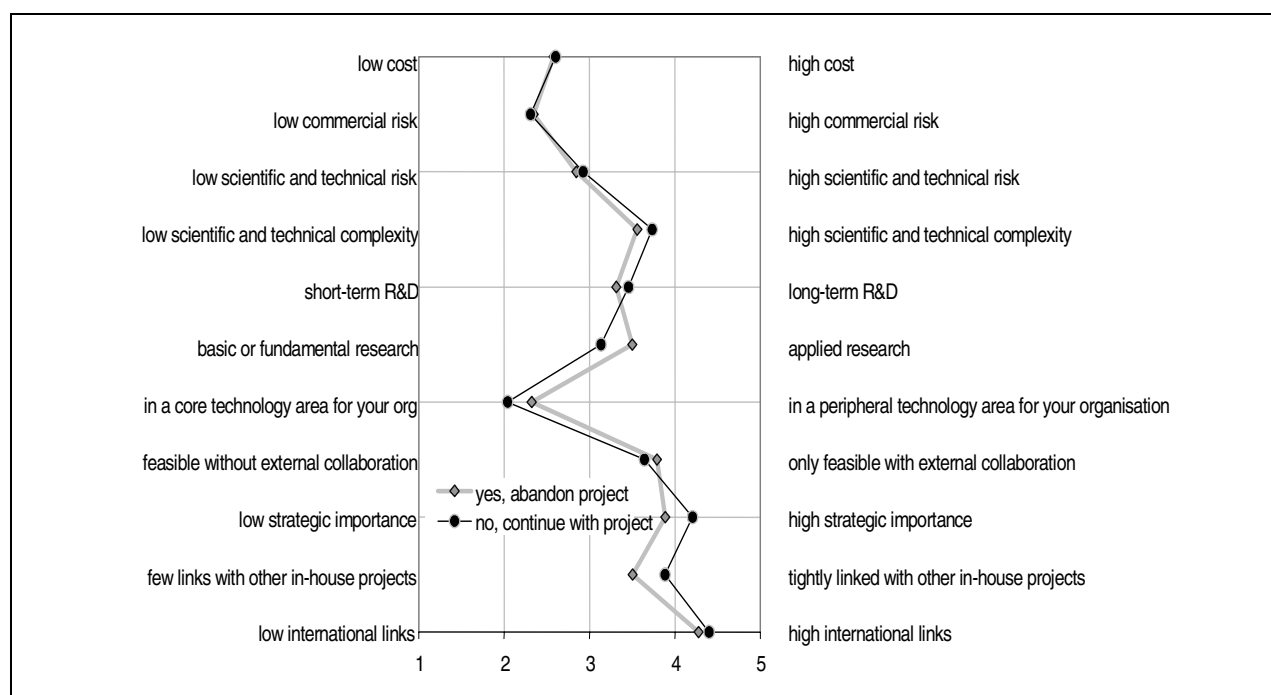
Source: Final Report: FP5 Impact Assessment – Survey conducted as part of the Five-year Assessment of EU Research Activities (1999-2003).

Pure additionality

Fifty-seven percent of the participants in the FP5 impact assessment exercise, when asked what they would do with their project in case they had not received funding, stated that they would abandon it, although almost 70% of them considered it to be of great strategic importance for their firm. In order to triangulate these results, a comparison of these percentages across the answers given in the rejected applicants' telephone survey was performed. Indeed, 84% of them stated that they did not undertake their rejected project after all, although 40% of them considered it to be of great strategic importance.

Furthermore, organisations that were more likely to abandon their projects without FP5 funding were private as opposed to public or semi-public organisations. The projects found to have higher abandonment rates were of lower scientific and technical risk and complexity and had a shorter time scale. They had more of an applied nature as opposed to basic research, were in a peripheral technology area of the firm, were of lower strategic importance, and promoted fewer linkages with other in-house R&D projects and international networking (see Figure 13.2).

Figure 13.2. **Additionality: nature of projects**



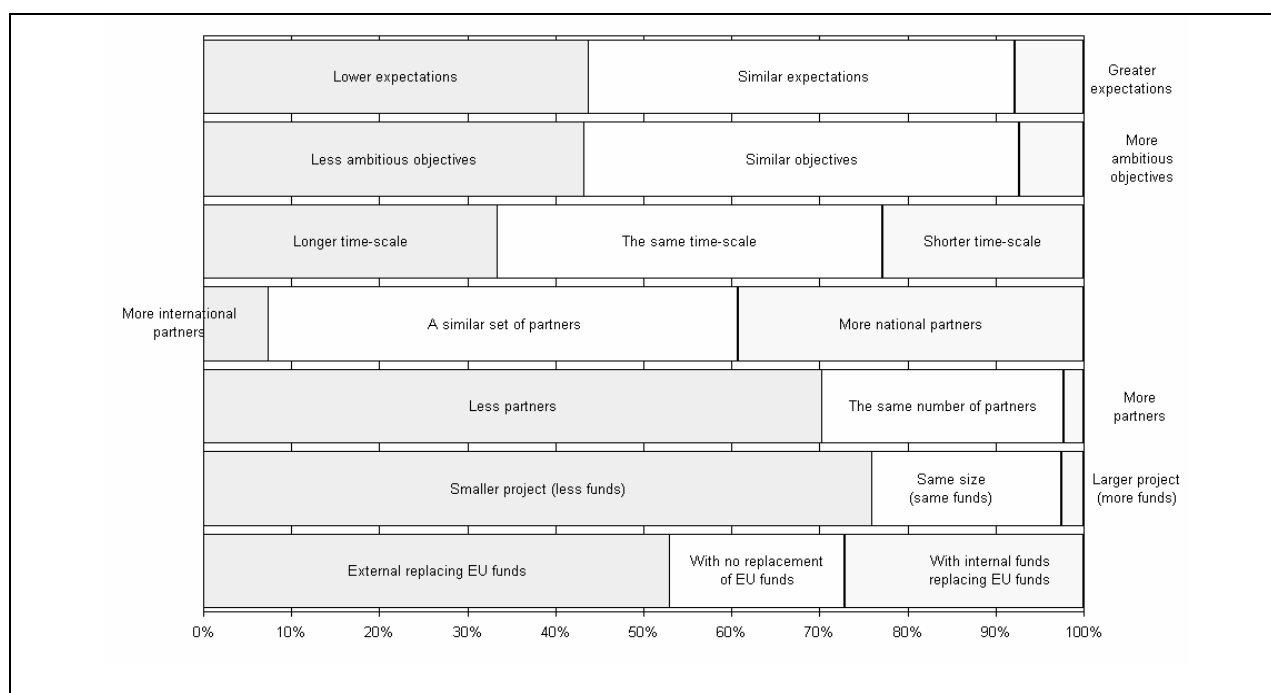
Source: FP5 Impact Assessment – Survey conducted as part of the Five-year Assessment of EU Research Activities (1999-2003), Annex 9.

Behavioural additionality

Thirty-six percent of the total population of the main survey stated that they would carry out their projects in the event their proposals were rejected for FP5 funding, but it would have affected the elaboration process in terms of timing (acceleration additionality), collaboration and networking (scope additionality), funds and sources of funding, expectations of net benefits and ambitiousness of objectives.

With respect to 'acceleration additionality', one in every three participants stated that it would take more time than originally anticipated to carry out their projects. Seventy percent stated that they would have to settle for fewer partners and 39% would carry the project out with more national partners as opposed to international ones ('scope additionality'). With respect to funding options, 76% stated that they would carry out their projects on smaller scale (less funds) and 20% with no substitute for the EU funds. In terms of how their expectations of the benefits they would gain from their projects would be altered, 44% stated that they would be lower. Finally, 43% of the respective population stated that their objectives would be less ambitious (see Figure 13.3).

Figure 13.3. FP5 participants: possible changes in project characteristics

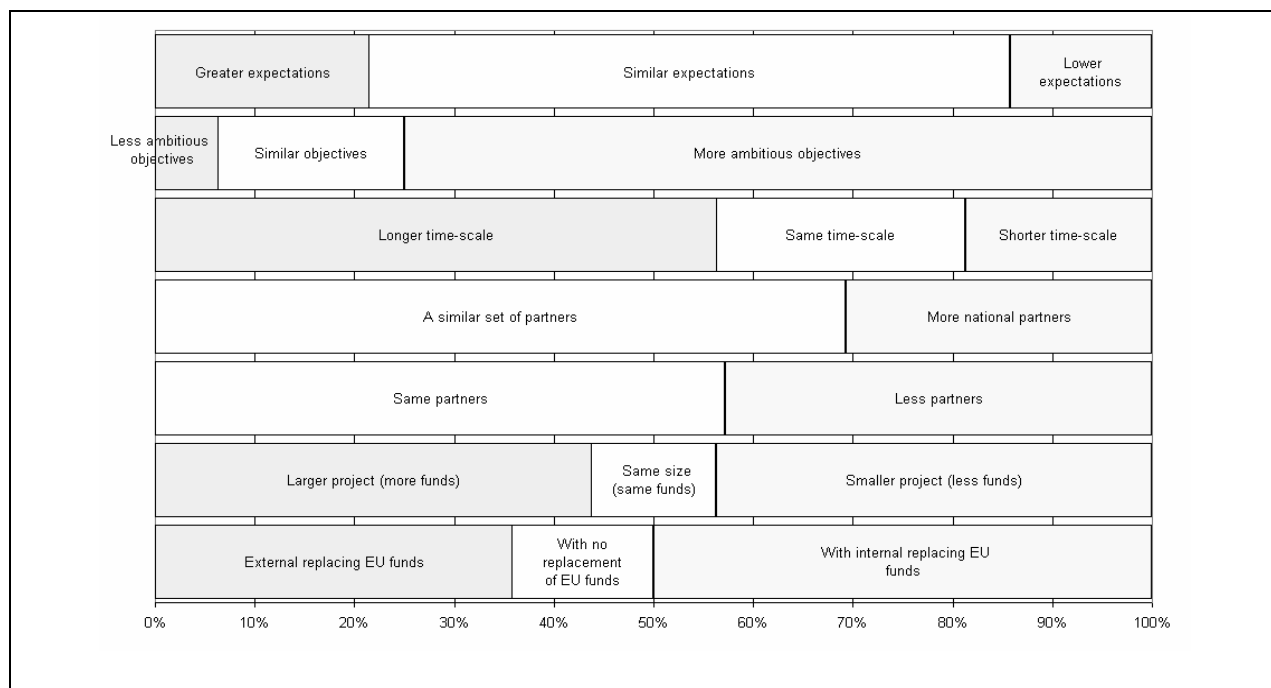


Source: Further elaborated data from the FP5 Impact Assessment exercise

The same question was also put to the applicants whose proposals were rejected for FP5 funding, and 16% stated that they did actually carry out their projects. More than half of them stated that the project took longer to complete (acceleration additionality), 43% stated that it was conducted with a smaller consortium, and one out of every three rejected applicants constructed their consortia with more national partners as opposed to international partners (scope additionality). With respect to funding options, almost half of the respective population stated that the project was undertaken with less funds, only 10% stating that they did not actually substitute the EU funds with other sources (own

funding). Interestingly, only a small portion of the rejected applicants who did carry out their projects stated that the objectives of their projects were less ambitious (6%) or that their expectations were lower (14%) (Figure 13.4).

Figure 13.4. **Rejected applicants: actual changes in project characteristics**



Source: Further elaborated data from the FP5 Impact Assessment exercise

The behavioural additionality results were cross-tabulated with the importance of the projects for the participating organisations. It was found that the vast majority of the participants considered the projects to be of high strategic importance and only a fraction considered them to be of moderate or low importance.

It was also seen that FPs in general help organisations build their R&D capabilities. The organisations that stated that their future R&D projects would not be continued in general also indicated higher rates of project abandonment failing FP5 funding, as opposed to the organisations that stated that they would continue to undertake R&D projects in the future. In addition, 28% of the total population surveyed stated that they will continue to apply under the EU's Framework Programmes by building on past R&D experience accumulated through conducting projects funded by previous FPs. Interestingly, among those who had entered new areas of research in the past (25%) almost half stated that they will continue working in these areas in the future and seek funding mainly from FPs or national programmes. Hence, the Framework Programmes are an important instrument not only for funding R&D projects but also for helping organisations to enter into or continue research in new areas which usually bear high rates of risk or uncertainty -- two parameters that can restrain a firm from undertaking such projects. However, it should be noted at this point that previous FP experience was not found to be a predictor of additionality (see Table 13.1).

Table 13.1. **Project chains**

		Future				
Past		In-house	Framework programme	National programme	Not continuing	
	In-house	70%	40%	41%	7%	78%
	Framework programme	35%	28%	23%	3%	40%
	National programme	42%	27%	34%	4%	47%
	New area	18%	11%	11%	4%	25%
		84%	49%	49%	10%	

Source: Final Report: FP5 Impact Assessment – Survey conducted as part of the Five-year Assessment of EU Research Activities (1999-2003).

The elaboration of the FP projects also affected the collaborative behaviour of the participants. The vast majority of them stated that the networks and partnerships they had developed through previous projects conducted in past FPs would be retained either in total (21%) or partially (61%). This means that the FPs have helped participants in building networks, which is crucial for carrying out R&D projects as organisations cannot afford to retain all of the necessary knowledge in-house (see Table 13.2).

Table 13.2. **FP5 partners**

		Future			
Past		Will work with all of them	Will work with some of them	Will not work with any of them	Total
	Had worked with all of them	7%	2%	0%	9%
	Had worked with some of them	14%	59%	1%	74%
	Had not worked with any of them	4%	11%	2%	17%
	Total	25%	72%	3%	100%

Source: Final Report: FP5 Impact Assessment – Survey conducted as part of the Five-year Assessment of EU Research Activities (1999-2003)

No additionality

All projects that would be/have been conducted in exactly the same way irrespective of receiving EU R&D funding fell into the category of 'no additionality'. Seven percent of the participating organisations stated that if they had not received FP5 funding, they would carry out their projects in a similar way to their FP5 proposal. More precisely, 8% would carry them out with the same amount of funds and 20% would replace the non-received EU funds with external funds; 9% would carry out the projects with the same number of partners and 16% with a similar set of partners; 15% on the same time scale; 17% with similar objectives and 16% with similar expectations in terms of net benefits.

According to the opinions provided by the rejected applicants with respect to this aspect of additionality, 11% stated that they carried out their projects in similar way; 28% replaced their EU funds with external funds; 13% carried out their projects with the same amount of funds as originally planned, more than half with the same number of partners and the vast majority with a similar set of partners. One in every four rejected applicants carried out their project on the same time scale, around 20% with similar objectives, and the vast majority with similar expectations in terms of net benefits.

Negative additionality

A small fraction of the total population that participated in the main survey (13%) stated that they would have done at least one thing “better” if their proposal was rejected for FP5 funding. Around 25% would have replaced the non-received FP5 funds with internal funds although only 3% stated that they would carry out their projects with more funds. Two percent stated that they would carry out their project with more partners and 8% with more international partners (as opposed to national partners). Interestingly, almost one in every four participants stated that it would take them less time to elaborate their projects. On the other hand, less than 10% stated that their projects would have more ambitious objectives or greater expectations in terms of net benefits.

In addition, it should be noted that no organisation that participated in the survey declared that they would have improved all aspects of their project in the event of rejection for funding.

With respect to the rejected applicants' survey, 11% stated that they did at least one thing “better”. None stated that they carried out the project with more international partners or with more partners in general; 19% stated that they did carry out the project on a shorter time scale; 1% with more ambitious objectives; and, interestingly, 21% stated that the expectations of their projects, in terms of net benefits, were higher. Also, 40% of the rejected applicants who carried out their projects replaced the EU funds with internal funds and 43% managed to carry out larger projects.

Summary and main conclusions

In the FP5 impact assessment exercise, several types of additionality were identified. The main results can be summarised as follows.

The statistical analyses performed on the results of the impact assessment exercise of the 5th European Framework Programme for Research and Technological Development revealed the fact that over half of the participating organisations and the vast majority of rejected applicants would not have carried out/did not carry out their projects in case/after their proposals for funding under FP5 were rejected (pure additionality). Around 40% of them considered these projects to be of high strategic importance. Thus, there was considerable evidence of pure additionality among participants. In this respect, the FP compares favourably with many national programmes that also intend to enhance the R&D capabilities of organisations.

Amongst those that stated that they would actually carry out their projects in the event that funding was rejected (behavioural additionality), the majority stated that they would replace their funds with external funds and only a small percentage stated that they would not replace the funds but simply carry projects out with their own funds. In terms of partnerships (scope additionality), most of the participants stated that they would carry out their projects with fewer partners but with a similar set in terms of national/international partners. Most considered that they would carry projects out on the same time scale (acceleration additionality) with similar objectives and expectations in terms of net benefits. In other words, the absence of FP5 funding had significant impacts on the size of the projects, the number of partners involved, the involvement of international partners and the time scale of the projects. Amongst the population of rejected applicants, the absence of FP5 funding resulted in carrying out some of these projects on a longer time

scale with similar expectations and partners but with no substitute for EU funds and, interestingly, with more ambitious objectives.

By triangulating the responses provided by the participants with those of the rejected applicants a conclusion can be drawn that rejection for Framework Programme funding can have a significant impact on organisations in terms of actually carrying out their projects, but when organisations decided to carry out projects that were rejected for FP funding, this had little significant impact on the actual process of elaborating the project.

After cross-tabulating the results between additionality and strategic importance of projects it was seen that, in FP5, very few projects of low or even moderate strategic importance to participants were funded, and the large majority (two-thirds) of projects were both additional and of high strategic importance to firms. In this respect, FP5 met the expectations of the Commission and EU R&D policy.

All in all, one could observe substantial behavioural additionality in the projects carried out under FP5. On the other hand, a few examples of negative additionality were also found: a small fraction of the projects would have been carried out in a better (larger, faster, more ambitious, etc.) manner outside the FP. These projects definitely would deserve closer examination.

In general, it was seen that future assessments of the different sorts of additionality would gain a lot *a)* from a better established monitoring system of the project outcomes and outputs which would provide a better grasp of output additionality; *b)* a kind of ex ante analysis – assessment of the project and the participants which would allow for before/after comparisons and ease the analysis of input additionality; *c)* a more extensive analysis of behavioural additionality including the types of ‘unwarranted’ effects, which in the present report are labelled negative behavioural additionality. Future investigations of behavioural additionality would, in addition to the survey approach applied, also make use of in-depth case studies.

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Government R&D Funding and Company Behaviour

MEASURING BEHAVIOURAL ADDITIONALITY

How does government funding of business R&D affect the behaviour of firms? Ongoing efforts to boost business investment in R&D demand better methods of evaluating the effectiveness of government policy instruments. Evaluations should investigate not only how much additional business R&D spending is stimulated by government support or how much additional output is generated as a result, but also how government funding influences the conduct and direction of business R&D. Do recipient firms pursue different types of R&D, or collaborate more with others? Do they improve their R&D management capabilities and introduce enduring changes in their R&D strategy and performance? Such issues are not typically addressed in traditional evaluations. Efforts to explicitly measure changes in the ways firms conduct R&D as a result of government policy – so-called “behavioural additionality” effects – have remained relatively underdeveloped.

This publication explores the emerging concept of behavioural additionality and summarises results of a multinational effort to develop better ways of measuring it. The analysis derives from a series of studies undertaken in Australia, Austria, Belgium, Finland, Germany, Ireland, Japan, Korea, Norway, the United Kingdom, the United States and the European Union. These studies reveal a number of qualitative changes in the types of R&D conducted by firms and the way in which they carry out R&D as a result of their participation in government R&D funding programmes.

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