WIFO
ÖSTERREICHISCHES INSTITUT
FÜR WIRTSCHAFTSFORSCHUNG

WORKING PAPERS

Measuring the Effects of Public Support Schemes on Firms' Innovation Activities

Rahel Falk

267/2006

Measuring the Effects of Public Support Schemes on Firms' Innovation Activities

Survey Evidence from Austria

Rahel Falk

WIFO Working Papers, No. 267
January 2006

E-mail address: Rahel.Falk@wifo.ac.at
2006/010/W/0

Measuring the effects of public support schemes on firms' innovation activities

Survey evidence from Austria

RAHEL FALK

Austrian Institute of Economic Research (WIFO)

A-1103 Vienna; P.O. Box 91

Phone: 43-1-7982601-238; Fax: 43-1-7989386

Rahel.Falk@wifo.ac.at

Abstract:

This paper discusses conceptual frameworks for measuring the effects of innovation policy and begins with applying conventional descriptive methods to explore how firms rate and rank the merits of public intervention. Based on survey data from some 1200 Austrian firms we then challenge the hypothetical survey question ("What would you have done if public support was denied?") by comparing the respective answers with changes that actually occurred when public assistance was refused. This is a contribution to the ongoing literature as is the attempt to relate any of the observed additionalities to the firms' characteristics, their perceived barriers to innovation and the degree they make use of the public support system. The effects of policy interventions prove to be cumulative in a dual sense. On the one hand, our results confirm the well-known notion that large firms make the best use of funds. On the other hand, substantial changes in the way a company undertakes R&D&I-related activities appear to only result from multiple policy interventions of different kinds. While supported firms tend to immediately increase their resources devoted to innovation projects, the result-based concepts of additionality only come into effect once a threshold level of intervention has been reached. Acknowledging that a public innovation support system already incentivises potential beneficiaries to change their innovation-related behaviour, and that eventual success in terms of outcomes does not arise from some discrete support measure, but from the synergies of multiple policy action, we conclude that future work should focus more on the evaluation of portfolios of programmes and their interactions.

JEL: C25, C42, H50, O31

Keywords: innovation policy; policy evaluation; methods

I would like to thank Luke Georghiou, Michael Paffermayr and two anonymous referees for helpful comments.

1. Introduction

Depending on the perspective of innovation, or rather on the perspective of innovation *failures*, policy makers hold different views on the main role of adequate policies. The traditional school identifies three prime sources of market failure which impede the generation of optimal amounts of knowledge in the fields of science, technology and innovation (STI). [1] First, innovating firms bear high costs when generating new knowledge, but cannot reap the full benefits thereof, because the knowledge spills over to society as a whole, competing firms included. This is the well-known appropriability problem associated with the nature of knowledge as a public good; it causes distinct disincentives for STI-related investments. Second, the primary generation of knowledge may require a scale of effort larger than individual firms alone could generate or sustain. Third, initial investments involve a range of risks and uncertainties, yet at the same time markets that insure against these risks either do not exist or they do not function properly due to information asymmetries on the part of the innovating firm and potential investors.[2] If the primary generation of new knowledge is constrained, then the government should assist firms by channelling sufficient amounts of resources to the innovation activity. In this light, policy intervention is considered the more effective the more firms are encouraged to spend their resources on STI-related activities. As the traditional perspective on innovation processes is a linear one, the success of public assistance should be equally visible in terms of greater innovation outcomes.

The system failure perspective locates the bottlenecks of innovation not so much in the primary generation of knowledge, but in a more fundamental problem.[3] In the first place, firms are said to suffer from "bounded vision" (Fransman, 1990, Georghiou et al. 2003, p. 28). When faced with high-pressure deadlines managers tend to disregard the value of new knowledge, unless it emerges from areas where the firm is currently carrying out activities. If they are aware of the importance of new knowledge, the firm's ability to transfer, assimilate and ultimately apply knowledge to commercial ends often requires a (much too) high level of absorptive capacity. Modern approaches to innovation policy therefore focus on the acquisition of learning capabilities and problem-solving skills, including the ability to know where complementary expertise can be found. Consequently, innovation policies are considered the more effective the more they contribute to the intermediate goals of knowledge acquisition and diffusion. This approach accords well with the concept of behavioural additionality as originally introduced by Buisseret et al. (1995). It broadens the traditional additionality concepts by investigating whether policy intervention has led the actors to become more involved in STI-activities. It also assesses whether there have been permanent changes in the conduct of a company, especially in the institutionalization of any

---

[1]) An overview on the traditional neoclassical rationales for STI-policy is given, for instance, in Stoneman and Vickers (1988) and Sundbo (1998).

[2]) Both the public good argument as well as the risk argument have first been brought forward by Arrow (1962) in connection with knowledge. Indivisibilities or scale factors in STI have been first argued by Nelson (1959). Subsequently these arguments would come as the prime justification for a neoclassically inspired innovation policy.

[3]) Literature surveys include Dodgson and Rothwell (1994), Freeman (1994), Metcalfe (1995), Sundbo (1998) and Fagerberg et al. (2004), section II.

activities related to the innovation process (Aslesen et al., 2001). In short, the focus is on the building of innovation capabilities and competence building in general, as well as on the companies' ability to make use of new technologies and R&D-procedures elsewhere. If this is the case, this can 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 a country's innovation investment.

This paper discusses conceptual frameworks for measuring the effects of innovation policy, applies descriptive methods to explore how firms rate and rank the merits of intervention and suggests some methodical extensions. The paper is organised as follows: Section 2 describes and classifies various additionality concepts and their sub-dimensions and discusses how they interrelate with each other. While there are numerous econometric studies on both input and output additionality[4], empirical evidence on behavioural additionality has remained sparse and mainly anecdotic until recently. This deficiency is mainly due to the limited availability of useful data. Physical resource inputs are easy to track and innovation outcomes are recordable, however intangible behavioural changes resulting from government intervention are much more difficult to monitor. Accordingly, the third section briefly discusses empirical approaches to the behavioural concept, while the fourth section applies and extends the present methods. Based on survey data from some 1200 Austrian firms we qualify the descriptive findings on the effectiveness of innovation policy by relating any of the observed additionalities to the firms' characteristics and their perceived barriers to innovation. This is a contribution to the ongoing literature, as is the attempt to explore the robustness of respective results from survey data. We challenge the survey question "What would you have done if public support was denied?" by comparing the respective answers with changes that actually occurred when public assistance was refused. The findings from the fourth section offer some insight into the appropriateness of current innovation support measures in Austria, and challenge the traditional concepts of how to measure their effects. The last section concludes with a discussion of the direction which future work on additionality should take.

2. Conceptualising Additionality

Several additionality concepts have been proposed as a way to measure the effects of public assistance on firms' innovation activities. They can be classified in three broad categories: *resource*-based concepts, *result*-based concepts and concepts that measure the success of policy intervention by examining desirable changes in the *process* of innovation.

[4] David et al. (2000) survey the econometric contributions to input additionality, Streicher et al. (2004) provide evidence for Austria and García-Quevedo (2004) conducted a meta-analysis on this issue. A comprehensive survey of the microeconometric evidence on output additionality is due to Klette at al. (2000). More recent international contributions on output additionality include Branstetter and Sakakibara (2002) or Czarnitzki et al. (2004). Austrian evidence is provided by Garica and Mohnen (2004) and Falk (2004).

The most obvious way to evaluate the effectiveness of public support is to determine whether it has resulted in so-called *project additionalities* (e.g. Davenport et al., 1998). Project additionalities are in place if the research project is cancelled, unless it is supported by public funds. It has been observed, however, that in many cases firms do not follow a rigorous approach when deciding on implementation or non-implementation. Instead, they tend to adapt the size of their projects or investments when public support is denied or granted. Accordingly, so-called *scale additionalities* are said to be on hand if public funding allows the project to be conducted on a larger scale. In a way, scale additionalities describe the gradual variant of binary defined project additionalities. The third concept which relates public intervention to its impact on the firm's resources is *input additionality*. Here, the focus is on whether and to what extent firms increase their private spending on innovation-related activities when supported – i.e. whether the firm itself spends at least one additional Euro on the research project for every Euro received in subsidy. This concept emphasises the leverage effect of public funding and is therefore the most refined one of the resource-based concepts. Clearly the three aforementioned concepts may stand in conflict with each other. One can easily imagine a situation in which project and scale additionalities occur, but the firm does not spend the entire subsidy on its target activity, let alone contribute its own funds (hence no input additionality).

The main problem with resource-based notions of additionality is that they rely on the oversimplified linear model of innovation which assumes a direct link between primary "innovation inputs" and respective payoffs. However, additional innovation resources do not inevitably result in increased innovation output and conversely, innovations are not merely the result of increased investment in tangible assets. Empirical evidence suggests that many companies, especially in the service sector, typically do not innovate by expanding R&D-related inputs (Gottschalk and Janz, 2003, and Tether, 2003). Instead, their innovation activities tend to rely more on creative and cooperative efforts, organisational change and new ways of offering services. E-banking and e-commerce are good examples of the latter.

Output additionality therefore deals directly with the most decisive impact, i.e. with the effect of public funding on results. It measures the proportion of output that would not have been achieved without public support. Output is either defined in terms of marketable output (e.g. patents or successful innovations) or commercial output (e.g. sales or profits that are directly attributable to public R&D assistance). Results might also be defined in terms of enhanced productivity or a better competitive position, in which case the term *impact additionality* has been suggested. For obvious reasons, the case of impact additionality is hard to verify and the same applies to output additionality when the relevant indicator is commercial output. The innovation process requires a certain amount of time, as does the final product launch. With such a long time to market, the effect of initial public assistance is likely to be blurred. Many empirical studies therefore draw on marketable output, especially patents. However, this only superficially solves the measurement problem: Patents or other intellectual research output are of no value to the firm unless they are converted into cash.

Hence, the fundamental drawback of the result-based measures is that the relevant dimension of innovation outcome cannot easily be attributed to intervention, while resourced-based measures leave the crucial transformation process of innovation input to innovation output within the black box. As a way out of this dilemma, Rigby (2003) proposes to condition the provision of public money on high output additionality, while high input additionality should be treated as a kind of second order condition. In light of the scarcity of public funds, he (among others) argues that the second order test ensures that publicly funded R&D does not substitute or even crowd out private R&D-investment and that the latter additionality concept serves as "a measure of the leverage effect of public money on the private resources of the firm".

Without questioning the ultimate need for an efficient use of public resources, there is increasing awareness of the fact that the traditional additionality concepts do not adequately capture the impact of public intervention on the innovation process itself. Accordingly, a third notion of additionality has been introduced: *Behavioural additionality*. It deals with "the difference in firm behaviour resulting from the intervention" (Georghiou, 1997). These changes should be permanent in character and should allow for a more efficient transformation of innovation inputs into innovation outputs, i.e. it is assumed that firm behaviour is changed for the better. The largely conceptual papers on Behavioural Additionality have proposed several refinements.[5]

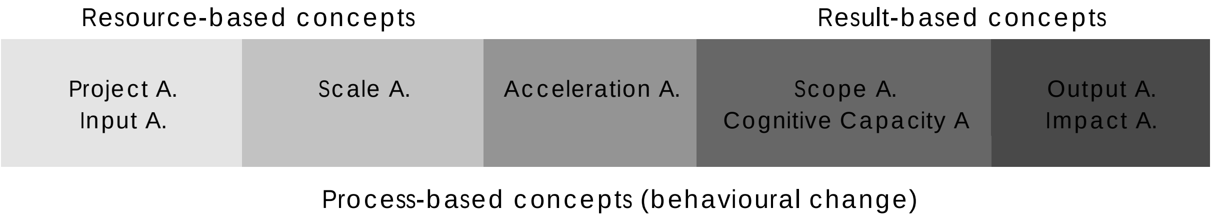
Scope additionalities refer to cases where the coverage of an activity is expanded to a wider range of markets, applications or players than would have been possible without public assistance. The case of assisted firms advancing into new research areas could be reflected in a greater risk profile of the innovation projects, since activities in areas beyond the firm's key competencies entail greater technical difficulty (hence an increase in technical risk) and bring about less predictable business success (hence an increase in commercial risk). On the other hand, new partnerships between the business and academic spheres could serve as prime examples for an enlargement of the original group of participants. In the same way collaboration networks (within or between sectors) which would not otherwise occur are an indicator of scope additionalities. As collaboration and networking involve both individual and organisational learning, thereby increase the competencies of the actors and enhance their absorptive capacity, some authors (such as Hyvärinen, 2005) refer to the positive impact on competencies and expertise as *cognitive capacity additionality*. Whether cooperations in innovation are classified as scope additionalities or cognitive capacity additionalities, or even as the desirable result of some support measure – the crucial point is that the firm's future innovation behaviour is affected in a positive and sustainable way.

At last, funding can affect the timing of the project. Acceleration additionalities are said to be in place if participation in innovation schemes speeds up the course of the project. Observable outcomes are, for example, an earlier starting date of the project, a shorter implementation phase, or project results accessible at an earlier date. Firms could also anticipate acceleration additionalities (shorter time to market) and therefore be less reluctant to engage in more long-term projects. If at the same time these long-term projects

[5] See Georghiou (1997 and 2002), Georghiou et al. (2000 and 2003), Lukkonen (2000), Papaconstantiou and Polt (1997).

are geared to strategic objectives and supported firms decide to carry on research in areas beyond short-term business needs, then acceleration additionalities come along with scope additionalities. Of course, the “initiation of new lines of research” event could also be classified as an impact additionality if the firm thereby succeeds in strengthening its competitive position.

Figure 1: Additionalities in resources, processes and results



A final note refers to the conceptual fuzziness with respect to scale additionalities. When a firm engages in larger innovation projects as a result of funding, it has changed its behaviour to such an effect that larger amounts of resources are channelled into the activity. I prefer to rank scale additionalities among the resource-based concepts, but other authors classify them as a sub-category of behavioural additionality. Figure 1 illustrates how the subcategories of behavioural additionality (scale, acceleration, scope and cognitive capacity) merge at the interfaces to the resource-based and the result-based additionality concepts.

3. Empirical approaches to Behavioural Additionality

Many papers dealing with behavioural additionality allude to the econometric approaches, but do not apply them. To the best of my knowledge, the rare exception is a paper by Wong and He (2003) who exploit survey-data from 135 manufacturing firms in Singapore. In fact it is hard – if not impossible - to adapt standard econometric techniques to the behavioural concept. Variables that capture behaviour would have to be regressed on the incidence or even the size of public assistance, while one controls for other influencing factors. The cardinal problem is, of course, finding suitable left-hand side variables. Behaviour is as such inherently intangible; it only becomes manifest in terms of results. We could, for instance draw conclusions about the firm’s attitude towards risk based on the observed volatility of profits, or we could estimate the time-frame of its research activities by looking at the average duration of the projects. However, even if a firm reacts promptly in some well-defined measure, the resulting observable changes in behaviour will lag behind. Clearly, the greater the time lag, the less compelling is the assumed link between cause and effect. Although this concern generally applies to any of the above additionality concepts, it is particular severe in the fuzzy behavioural context. This is also true for the other main problem connected with the regression approach: the fact that the control variables, and arguably an entire range of additional, unobserved factors, not only affect the realised additionalities, but also the decisions of the managers of some well-defined programme to support some firm. Advanced papers address such correlations and instrument the participation decision.[6] The major difficulty is no less challenging than the former one, namely to find valid instruments that have an influence on the support variable, but not on the behavioural changes resulting from the intervention.

These problems are hard to solve. For this reason, hitherto existing empirical analyses of behavioural additionality are based on one of two frameworks. In the first, supported firms are compared to unsupported ones in terms of any of the aforementioned indicators of behaviour, e.g. with respect to the size of their projects, their willingness to cooperate, and their willingness to engage in risky R&D, etc. Simple comparison group analyses have been carried out, for instance, by Hyvärinen (2005) for Finnish firms (TEKES-customers and non-customers) or by Shipp et al. (2005) for US firms (ATP-customers and non-customers). The general picture emerging from these studies is that supported firms are characterised by significantly superior innovation performance and related issues than the non-supported ones. The serious drawback of the comparison group approach is that – again - one cannot tell whether (behavioural) additionalities are merely attributable to the type of firms that select into support schemes. To separate the selection effect from the funding effect, matching methods would be in order. This boils down to a conventional comparison group analysis with the crucial difference that the descriptive analysis draws on a “matched” sample. Ideally, matched firms are identical except for their funding status. Yet such an approach has never been followed in the behavioural context.

The other way to assess the issue of behavioural additionality - as followed, for instance, by Davenport et al. (1998), Aslesen et al. (2001) or Pegler (2005) - is to question assisted firms directly. This would involve asking recipients of public support how their innovation related behaviour changed, asking formerly supported firms how the withdrawal of assistance affected their innovation related behaviour, and asking non-supported firms how their innovation related behaviour would have changed had they received support. Surveys are a good solution, provided, of course, the respondent does not answer strategically and provided she is able to reflect behavioural changes in a counter-factual situation.

4. The effects of innovation policy: survey evidence from Austria

Based on recent survey data, the following chapter provides some evidence on the effectiveness of the Austrian innovation support system. After introducing the data and the survey design, section 4.2 looks at the additionality effects as claimed by the respondents. One of the helpful features of our survey is that it includes questions on behavioural change in the event of rejection which are not merely hypothetical (i.e. “Would the project have been conducted without public support?”). Instead, we can also compare such results with answers from respondents whose proposals have actually been rejected. The results from this comparison will be presented in section 4.3. At last section 4.4 qualifies the previous findings

[6] In Wong and He (2003) the funding status remains exogenous.

by identifying the types of firms which make best use of public assistance and by estimating the level of intervention necessary to trigger any of the afore mentioned dimensions of additionality.

4.1 The data and design of the survey

In 2004 the major federal R&D support scheme in Austria (then known as the FFF, now part of the FFG) commissioned a study to see how customers evaluate its performance.[7] In this context, a detailed questionnaire was sent to 3652 firms that had submitted a research proposal to the FFF – whether it proved successful or not. A total of 36 percent of these firms (1298) filled out and returned the questionnaire on time, thus comprising our revised sample.

The survey began with a basic background section on various firm characteristics, such as the number of employees, sectoral affiliation or year of foundation of the firm. We distinguished between four aggregate branches: low-tech as opposed to R&D-intensive manufacturing industries (24 percent and 30 percent of the revised sample) and traditional as opposed to knowledge-intensive services (11 percent and 28 percent of the revised sample). A total of 72 firms fell into the primary sector and were deleted from the following empirical analysis, as were those companies which failed to report their sectoral affiliation. The first two columns of Table 5 in the Appendix provide some details on the aggregation of branches. Second, we identified four size groups. Every third sample firm belonged to the micro-sector which consists of firms with less than 10 employees. Another third of the firms employed between 10 and 99 persons and 12 percent employed between 100 and 249 employees. 14 percent of the firms were considered large, having more than 250 employees. Table 6 in the Appendix gives the joint distribution of sectoral affiliation and firm size categories.

Among other issues, subsequent sections deal with perceived barriers to innovation[8] and the type(s) of public support granted during the previous eight years (if any). It turned out that only 11 percent of the sample firms had not been assisted by any innovation support measure, i.e. they had received no tax relief and no direct assistance from national or European support schemes.

4.2 Descriptive evidence on resource-based and behavioural additionalities

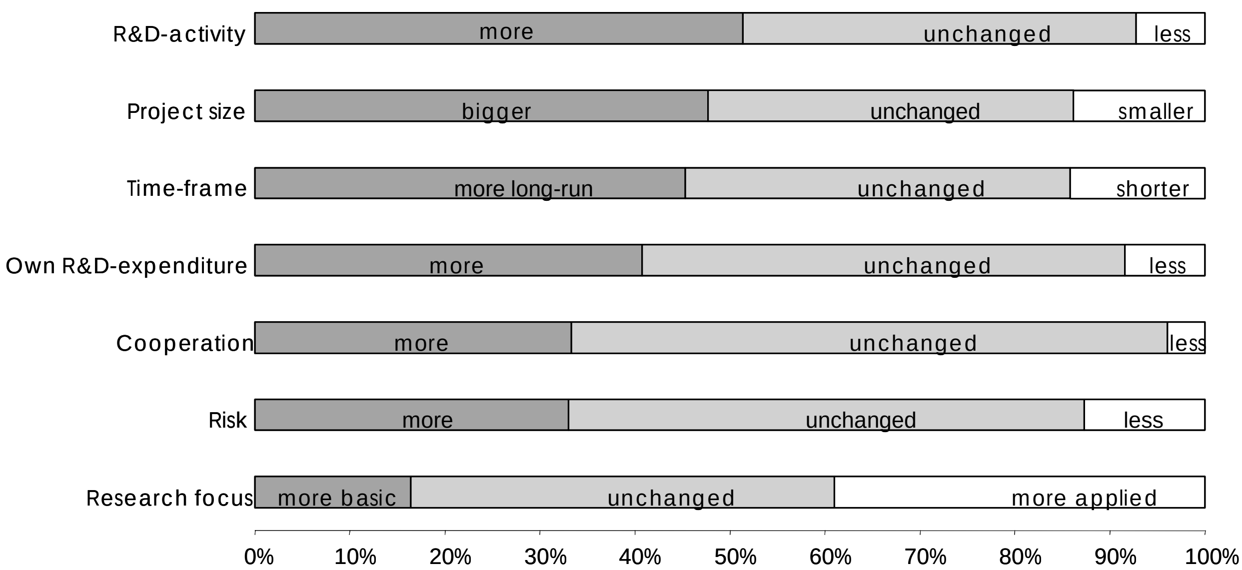
Regardless of their funding status, firms were first asked to assess the benefits accrued from the entire range of (potentially) available innovation support measures. The exact wording of the question was: "How does the Austrian system of innovation support affect the ways your company carries out innovation-related activities?" The respondents were then asked to choose from three possible alternatives, e.g. "we carry out bigger projects", "the scale of the projects remains unchanged" and "we carry out smaller projects". Figure 2 illustrates the answers.

[7] For details on the survey see Schibany et al. (2004), chapter 6.

[8] The hampering factors will be discussed in section 4.3. Figure 3 in the Appendix provides a list that ranks the urgency of the proposed factors.

The first surprising result was that even unsupported firms reported that they had realised various types of additionalities – a finding that casts serious doubt on the generally assumed direction of causality. Obviously, anticipated changes in firm behaviour not only result from participation, but also from the funding criteria. If the firm meets these criteria, and maintains them irrespective of its acceptance by the funding institution, then the additionality arises from the application and is not the result of participation in support measures. As firms generally change their manner of undertaking R&D activities in a gradual way, the question of cause and effect appears to be anything but settled within the behavioural context.

Figure 2: Additionalities arising from the Austrian innovation support system[a)]



Source: FFF-survey; [a)] includes supported and unsupported firms

Every other firm intensified its research activities giving rise to project additionalities. 16 percent of the firms invested more in basic research, while 40 percent enlarged their applied work. In contrast to the other (sub-) dimensions of additionality, there is no a priori reason why either of these changes in research focus should be regarded as preferable. This said, the vast majority of firms reacted in the anticipated "right way", so there can be no doubt as to the general effectiveness of the Austrian support system for innovation related activities. In addition to the overall project additionality, additionalities accrue in terms of the size of the project with 48 percent of the firms realising scale additionalities. As regards the time-frame of the project, 45 percent of the sample firms stated that they had engaged in more long-term projects indicating that assisted firms take acceleration additionalities into account. Classical input additionality ranked fourth, followed by greater willingness to undertake risky R&D and greater openness to collaboration (both at 33 percent).

How do these findings compare to other studies? During the last two years an OECD working group has been exploring the measurement of behavioural additionality through a series of linked national studies (OECD 2005). The studies are framed in very specific national contexts and the approaches varied considerably in terms of target group and survey design. The contributions widely agreed on the importance of the behavioural aspect in evaluating the effects of policy. Apart from this general finding it is hard and arguably not rather useful to present overall result tables. There is certainly wide agreement that acceleration additionalities matter a lot – which is perfectly in line with our findings. On the other hand, the role of public support in influencing firms' cooperation strategies is more controversial. The study from Finland answered in the negative, while evidence from Germany and the US concluded that cooperation strategies were influenced in a highly significant way. The way respondents see this issue obviously hinges on the exact wording of the survey question. The assisted project might have *involved* cooperation, existing partnerships might have been *intensified* or additional cooperations might have been *newly founded*. As an example, in our case some 30 percent of the respondents claim that public support helps them to engage more in cooperative activities. At the same time every other firm states that the assisted project involved cooperation of some kind. Some of the confusion might also be attributable to different classifications of observed additionalities. If the aim of a specific support programme precisely is to establish partnerships, then eventual success comes rather as a project additionality, i.e. the (collaboration) project would have failed without intervention.

4.3 Behavioural changes in case of rejection: hypothetical vs. actual situations

The analysis of directly asked questions on additionality assumes that the respondents are indeed able to reflect on their behaviour in hypothetical, counter-factual situations and that they are telling the truth to the best of their knowledge. However, as respondents have an interest in the continuation of public support, they might be tempted to over-emphasize the merits thereof (Sakakibara, 1997). On the other hand, one could argue that companies might be reluctant to admit their dependency on public funds in order to demonstrate that they are in line with the basic funding principles of complementarity and sustainability. Either way, the differences between hypothetical and real situations should, if possible, be assessed, and our survey allows for this kind of investigation.

Table 1 presents some evidence on hypothetical and actual project additionalities. It is important to note that analyses in this sub-section do not refer to the Austrian innovation support system "in general", but to the perceived merits of one particular scheme – that of the FFF. Hypothetical answers come from firms having never experienced rejection by the FFF, while the last column gives the percentage answers of firms whose applications have failed at least once. Based on their experience, these respondents can report on what actually happened to a rejected project. Table 8 in the Appendix details the analysis by firm size and sectoral affiliation.

Obviously, the readiness to carry out the original project even when no support was granted has been systematically underestimated. Conversely, a substantially smaller fraction of firms (47 as opposed to 57 percent) would be prepared to implement a revised version of the proposed project. This suggests that the revision of research proposals requires more of an effort than firms generally anticipate. In consequence, more firms than expected either cancel the project or implement it without changes. The extent of a firm's false assessment of

Table 1: Implementation/non-implementation if application is rejected

In case of rejection, the project...	Hypothetical Scenario[a)]	Actual Consequences[b)]
… is carried out without changes (no project additionality)	13.36	21.93
… is carried out, but with changes (partial project additionality)	56.82	46.70
… is cancelled (full project additionality)	29.82	31.37
Number of sample firms	711	424

Source: FFF-survey; a) only refers to firms that have never experienced rejection by the FFF; b) answers relate to firms that have experienced rejection by the FFF.

its own readiness to carry out a revised version of the project is particularly high for companies with more than 10 but fewer than 100 employees, while micro-sector firms generally display the most realistic self-assessments.[9] The detailed analysis by firm-size also shows that the largest firms are *not* those which prove to be the least reliant on FFF-funding. It is true that within this size category the share of respondents who claim that no project additionalities arise from FFF-funding is highest and, conversely, the share of companies reporting full project additionality is lowest. However, when we depart from the hypothetical scenario and take a look at the actual consequences, we find that additionalities are the lowest for companies with above 100 and below 250 employees. This irregularity aside, it remains true that small firms are the most vulnerable to a withdrawal of support, corroborating the findings from the recent studies on behavioural additionality (OECD 2005). In summary, the detailed analysis by firm size in Table 8 supports a U-shaped relationship between the size of the firms and the effects of public funding.

Furthermore, the right panel of Table 8 in the Appendix shows that the decision to implement a project even when FFF-assistance is denied depends on the firm's sectoral affiliation. Service sector firms seem to be the most sensitive to FFF intervention, with a share of about 40 percent stating that the project had to be cancelled when FFF-funding was denied.

Table 2 sheds some light on the revisions that would have come into effect had the FFF decided not to assist the project. Accordingly, the sample is reduced to the set of firms claiming that the project would have been implemented in some revised form in case of rejection. We observe great unanimity with respect to the accessibility of project results. In other words, the conceived and actual consequences do not really differ from each other.

Table 2: Behavioural Additionality: adaptations if application is rejected

	Hypothetical Scenario	Actual Consequences
Smaller size of the project (total)	78.11	62.38
Postponed starting date of the project (total)	35.53	46.43
Longer duration of the project (total)	56.73	63.64
Later accessibility of project results (total)	64.59	66.01
Technical demands less sophisticated (total)	51.50	42.08
Number of sample firms	414	213

Source: FFF-survey

[9] See Table 8 in the Appendix (left panel: analysis by firm size).

Two out of three respondents agree that project results could only be exploited at some point in time later than the original target date, supporting the notion that so-called “acceleration additionalities” really matter. We find that acceleration additionalities originate as an immediate consequence of postponed starting dates and prolonged implementation phases when there is no public sponsoring. In fact, delays are generally much more severe than expected. Finally, Table 2 shows that the fewest concessions are made when it comes to technical demands. In fact, the actual consequences are less severe than the hypothetical ones and the same is true for the scale issue. Still, more than 60 percent of the rejected firms say they carried out the project on a smaller scale when FFF-assistance was denied.

4.4 Qualifying the results: what promotes additionalities from public funding?

It is only a first step to verify what kinds of additionalities have been triggered to what extent. In order to draw some policy conclusions on the advancement of the national innovation support system, it is important to know what types of firms are particularly sensitive to policy interventions. Do observed changes in firm behaviour depend on certain firm characteristics? Is it merely the “usual candidates” who are in a position to reap the benefits of public assistance, or is the “marginal claimant” equally successful? In particular, is the support system responsive to perceived barriers to innovation? And how much support is necessary to trigger (behavioural) changes in favour of sustainable STI-investment?

To assess these issues in a methodologically sound way, it is necessary to go beyond the descriptive approach. In the following, we use the categorical variables from Figure 2 as dependent variables and estimate a series of ordered probit regressions. Note that the probit model does not “prove” the case of (behavioural) additionality by means of econometric techniques – based on the survey data at hand the former descriptive analyses give clear answers. Instead, the results will deepen the understanding about the drivers of additionality and the response patterns of firms to increasing doses of public support. On this account we include, the *number of support schemes* the firm has been enrolled in (“zero” being the reference case). As has been said before, the inclusion of a discrete support dummy always involves the participation issue. In our case the implied endogeneity problem is aggravated by the fact that supported firms participate in various funding schemes, each of them being designed for a particular target group. Given the limited set of available variables there is literally no way to endogenise the funding status in a methodically sound way. If we include the number of support schemes the firm is participating in instead, the type of support is irrelevant and hence the funding status entails no systematic information on the type of firm that benefits from a particular measure. For instance, firms participating in just one support program may appreciate tax allowances, they may have tapped soft financing loans from various national or regional innovation support programs or they may have attracted funds from the European Framework Programmes. As a consequence, the group of supported firms is less selective. Though this approach does not settle the cardinal problem of endogeneity, it becomes less severe.

Table 3: The drivers of Resourced-based and Behavioural Additionalities[a)]

Type of Additionaliy	Project	Input	Scale	Acceleration	Scope			
	More R&D&I	**More own resourc.**	**Bigger projects**	**Longer Time-frame**	**More Coop.**	**More Risk**	**more basic**	**more applied**
Supported by one scheme	0.260 (0.000)	0.142 (0.011)	0.184 (0.001)	0.173 (0.002)	0.071 (0.207)	0.079 (0.139)	-0.038 (0.221)	0.064 (0.242)
...two schemes	0.321 (0.000)	0.129 (0.021)	0.268 (0.000)	0.173 (0.002)	0.115 (0.044)	0.160 (0.003)	-0.050 (0.101)	0.086 (0.118)
... three schemes and more	0.360 (0.000)	0.208 (0.000)	0.251 (0.000)	0.168 (0.003)	0.207 (0.000)	0.177 (0.002)	-0.046 (0.146)	0.079 (0.165)
High Cost	0.052 (0.108)	0.021 (0.501)	0.083 (0.009)	0.020 (0.528)	0.012 (0.678)	0.027 (0.343)	-0.007 (0.729)	0.010 (0.728)
Technical Risk	-0.040 (0.228)	0.034 (0.296)	0.003 (0.927)	0.049 (0.136)	-0.009 (0.766)	0.077 (0.012)	0.003 (0.876)	-0.005 (0.876)
Commer-cial risk	-0.021 (0.505)	0.030 (0.318)	-0.029 (0.360)	-0.007 (0.821)	0.025 (0.399)	0.065 (0.021)	0.021 (0.259)	-0.033 (0.259)
Time to Market	-0.029 (0.376)	0.027 (0.396)	0.061 (0.061)	0.100 (0.002)	-0.020 (0.497)	-0.027 (0.340)	-0.006 (0.739)	0.010 (0.740)
Amorti-sation	0.024 (0.510)	0.000 (0.997)	0.034 (0.350)	0.021 (0.550)	-0.047 (0.145)	0.023 (0.477)	0.036 (0.100)	-0.056 (0.084)
Property Rights	-0.059 (0.087)	-0.040 (0.229)	-0.005 (0.873)	-0.053 (0.116)	-0.008 (0.794)	-0.028 (0.360)	-0.020 (0.306)	0.033 (0.318)
Organi-sation	0.029 (0.628)	-0.081 (0.125)	0.039 (0.508)	0.067 (0.259)	0.087 (0.139)	0.012 (0.818)	0.024 (0.514)	-0.036 (0.491)
Skill Shortage	0.011 (0.814)	-0.053 (0.202)	0.063 (0.163)	0.089 (0.046)	0.044 (0.298)	0.039 (0.344)	0.033 (0.242)	-0.050 (0.213)
High-tech Manufac.	-0.026 (0.513)	0.041 (0.288)	0.042 (0.298)	0.041 (0.303)	-0.037 (0.313)	0.025 (0.496)	0.022 (0.353)	-0.035 (0.344)
Tradition. Services	-0.032 (0.550)	-0.048 (0.348)	-0.077 (0.140)	-0.058 (0.263)	0.058 (0.279)	-0.034 (0.461)	-0.026 (0.367)	0.044 (0.393)
Knowl.-Int. Serv.	0.049 (0.288)	0.061 (0.177)	0.033 (0.474)	-0.020 (0.660)	0.065 (0.143)	0.039 (0.354)	-0.010 (0.714)	0.016 (0.718)
>10 employees	0.107 (0.006)	0.029 (0.440)	0.175 (0.000)	0.045 (0.240)	-0.027 (0.462)	0.083 (0.019)	0.041 (0.085)	-0.064 (0.078)
> 100 employees	0.186 (0.000)	0.007 (0.900)	0.217 (0.000)	0.097 (0.069)	0.050 (0.343)	0.134 (0.010)	0.072 (0.055)	-0.103 (0.029)
> 250 employees	0.097 (0.059)	0.019 (0.717)	0.226 (0.000)	0.207 (0.000)	0.073 (0.154)	0.184 (0.000)	0.155 (0.000)	-0.197 (0.000)
Start-up	0.011 (0.787)	0.022 (0.579)	0.116 (0.004)	0.080 (0.048)	0.039 (0.312)	0.022 (0.548)	-0.006 (0.782)	0.010 (0.785)
N	961	944	953	948	937	945	935	935
Observed Pr(y=1)	0.513	0.408	0.477	0.453	0.333	0.330	0.164	0.390
Predicted Pr(y=1)	0.521	0.410	0.493	0.469	0.318	0.333	0.153	0.387

Source: FFF-survey; [a)] marginal effects (p-values in parentheses)

Furthermore, a list of possible barriers to innovation enters the regression equation. The latter are coded as dummies where the reference group is given by the set of firms that rates the suggested obstacle as irrelevant. Last, we proceed as Wong and He (2003) and include basic background characteristics such as sectoral affiliation and size of the firm. As an additional control variable we coded a "start-up dummy" which is equal to one if the firm had been founded within the last five years prior to the survey.

Table 3 lists the marginal effects and associated marginal probabilities in the event of a positive change. The first important thing to note is that the predicted probabilities resulting from this specification (last line) deviate very little from their unconditional (observed) counterparts – i.e. the model is well specified. As one would hope, the realisation of various dimensions of additionality mainly depends on the number of different support schemes firms have taken advantage of. The responses to increased doses of public support reveal an interesting pattern summarised in Table 4.

Table 4: Kick-off and cumulative effects of public funding[a)]

		Cumulative effects? Yes	Cumulative effects? No
Immediate Effects?	Yes	Project Additionality, Input Additionality, Scale Additionality } Resource based concepts	Acceleration Additionality } Process based concept
Immediate Effects?	No	Scope Additionalities: more cooperation & more risk } Process – & Result based concepts	

a) Summarises results from the first three lines in Table 3

Firms tend to immediately increase their *resources* devoted to innovation projects and their additional resource input increases with the number of schemes in which they participate. Acceleration additionalities also immediately come into effect, but firms do not further extend the time horizon of their research projects when participating in more schemes. Finally, additionalities in scope are clearly once again accumulative, but they only come into effect once a certain threshold level of intervention has been reached. The willingness to engage in riskier projects or to create new collaborations only comes into effect after repeated treatment.[10] The latter accords well with the mixed evidence on the role of public policy in creating research collaborations results (see Wong and He (2003) and the previously cited studies). Both the kick-off and cumulative effects of funding can also be observed with respect to the size of the firm. Start-ups are typically small firms. In our sample, half of them have fewer than 10 employees on their payrolls (see Table 7 in the Appendix). These firms are more likely to engage in larger and longer term projects. Their probability of realizing scale additionalities is 11.6 percentage points higher than that of matured firms, and their

[10] The same holds true with respect to changes in the research focus, although, admittedly, the coefficient of "participation in two programs" is of borderline significance at best.

willingness to extend the time-horizon of their projects increases by 8 percentage points. At the same time, we find that scale and acceleration additionalities increase with firm size, as do project additionalities (1st column) and scope additionalities in the form of greater risk-taking and willingness to undertake basic research.

The finding that in Austria classical input additionality (2nd column) does not depend on the size of the firm is unusual. Schibany et al. (2004) showed that Austrian firms with fewer than 10 employees and firms with more than 250 employees exhibit the highest leverage from public funding. The different findings can most likely be attributed to the measure of input-additionality: Our survey-based analysis makes use of a categorical concept, i.e. the firm reports spending "more or less or the same amount of its own resources" on its STI activities.

Based on our admittedly broad classification, we find that firms experience (or do not experience) additionalities irrespective of their sectoral affiliation. We investigated this issue in more detail in a subsequent exercise where the original sub-branches entered the regression equations instead of the aggregate industries. The marginal effects associated with these branch dummies are displayed, where statistically significant, in the last column of Table 5 in the Appendix. The results show that quite a few industries from both the low-tech and high-tech manufacturing sectors show significantly higher probabilities of running more long-term projects than those in the reference sector (manufacture of metal products & parts). Any other behavioural change, such as engagement in more cooperative or risky projects or an investment in long-term projects, remains unaffected by the sectoral affiliation of the firm.

Finally, we turn to the question of how the Austrian support system responds to the perceived barriers to innovation. Companies undertaking R&D&I apparently struggle with a great deal of problems. Figure 3 in the Appendix ranks select problems in descending order of importance. The largest obstacles to innovation are the high costs thereof. More than 60 percent of the firms from the estimation sample complained about the pricey outlays that would restrict respective engagements. Cost-constrained firms benefit from the Austrian funding scheme insofar as they run projects on a larger scale than they otherwise would. Their probability of engaging in larger projects increases by 8.3 percentage points (compared to the reference group of unconstrained firms). Furthermore, the coefficient on "high cost" is just about significant in the first regression, i.e. cost-constrained firms conduct more R&D&I-projects than would be the case if there were no innovation policies in place. However, more numerous and larger projects do not induce the firm to devote more of its own resources to the target activity. The relevant marginal effect in the classical input additionality regression is far from statistically significant. Hence, increased investments are supported completely by the public sector. If the success of the Austrian innovation support system were to be judged on the basis of the classical resource-based concepts of additionality (i.e. project and input additionality), we would find that it is not effective in tackling problems other than the notorious complaint about the excessive costs of innovation. In particular, the acquisition problem of R&D is not effectively handled. Firms expressing a concern about the inadequate protection of intellectual property would reduce their R&D-activities even if they participated in a public R&D-promotion scheme. For this group, the probability of extending respective activities decreases by 8.7 percentage points and the decrease is significant.

With the exception of the unresolved issue of intellectual property protection, Austrian economic policies are effective in mitigating the firms' barriers to innovation. However, alleviations do not express themselves in terms of greater resource inputs, but rather in terms of behavioural changes. Commercial risks rank second in the list of barriers to innovation – every other firm addresses this obstacle and another 35 percent of the sample firms refer to the high technological risk associated with innovation activities. As one would hope, risk-constrained firms declare that the availability of support schemes has led them to engage in more risky R&D-projects. Long amortisation periods are also successfully dealt with to the extent that firms addressing this kind of problem tend to undertake more basic research and companies struggling with a long time to market are more willing to undertake long-term projects.

5. Conclusions

This paper deals with the effects of policy intervention in the fields of science, technology and innovation. Both traditional resource-based additionality concepts and the more recent concept of behavioural additionality are applied to a 2003 survey of Austrian firms, most of which received some form of public assistance.

The first important result is that the innovation support system *in general* is not only beneficial to firms that actually receive support, but also to potentially supported firms – though naturally to a lesser extent. Several conclusions may be drawn from this finding. First, since additionalities already accrue during the application process, the management of funding processes deserves greater attention. The incentive effects arising from "the right" funding criteria may have no less of an impact than the sheer amount of dedicated moneys. Second, the direction of causality between the causes and effects of funding is not as straightforward as the mainstream literature suggests. This challenges current econometric approaches to additionality and also raises some questions as to the usefulness of evaluating the performance of individual programmes. Direct questions on the merits of policy intervention are admittedly a crude way to investigate the performance of the national innovation system, and yet they are more instrumental in tracing the spillovers and synergies that arise from it.

The second major finding is that the effects of policy intervention are cumulative in a dual sense. On the one hand, our results confirm the well-known notion that the largest firms are the most likely to realize various forms of additionality. Depending on the methodical approach used, we observed either a linear or U-shaped relationship between policy intervention and additionality. In either case, large firms appeared to make the best use of funds. On the other hand, substantial changes in the way a company undertakes R&D&I-related activities appear to only result from repeated treatment, i.e. different kinds of multiple policy interventions are necessary in order to trigger scope additionalities in the form of more cooperation or a greater willingness to engage in risky basic research. This strongly supports what we previously argued: that, due to the cumulative nature of behavioural (and results-based) additionality concepts, the results of intervention only become visible years after the money has been spent, and that it is difficult to attribute changes in “the way a company undertakes its STI activities” to discrete measures or programmes. When one acknowledges that the success of policy intervention does not solely depend on individual funding schemes, it becomes clear that future work should focus more on the evaluation of portfolios of programmes and their interactions.

Similarly, our results suggest that the effectiveness of policy interventions cannot be adequately captured by relying on a single impact measure. Depending on the perceived barriers to innovation, different dimensions of (behavioural) additionality should be applied in order to draw conclusions about the effectiveness of a scheme or a system in general. Furthermore, it seems vital to link the resource-based and process-based concepts of additionality to eventual outcomes. Increased innovation inputs do not necessarily lead to more innovation output, and in a similar way, behavioural changes constitute only intermediate results. This concern particularly applies to scope additionalities. It is, of course, essentially desirable for firms to be encouraged to think ‘outside the box’ and beyond short-sighted business needs. In the end, however, behavioural changes should be economically justifiable; if not at the level of the firm, then certainly at the aggregate level.

Appendix

Table 5: Sectoral classification

Industry	abs. freq.	in %	Additionality (marginal effect, if significant)[a)]
Low-tech manufacturing industries	***310***	***23.9***	
Manufacture of food, beverages & tobacco	42	3.2	Longer time-frame (0.157)
Manufacture of textile & leather	16	1.2	Longer time-frame (0.278)
Manufacture of wood & wood products	35	2.7	Longer time-frame (0.257)
Manufacture of paper & paper products	15	1.2	
Printing, publishing & allied industries	8	0.6	
Manufacture of rubber & plastics	36	2.8	
Manufacture of non-metallic mineral products	22	1.7	Longer time-frame (0.199)
Basic metal & alloys industries	50	3.9	Longer time-frame (0.16)
Manufacture of metal products & parts	68	5.2	
Manufacture of furniture, jewelry & musical instr.	18	1.4	
R&D-intensive manufacturing industries	***393***	***30.3***	
Manufacture of basic chemicals & chem. Prod.	57	4.4	Longer time-frame (0.214); Bigger projects (0.167)
Manufacture of machinery & equipment	151	11.7	Longer time-frame (0.147)
Manufacture of office computing & accounting machinery and parts	9	0.7	More risk (0.350)
Manufacture of apparatus for generation & transmission of electricity	24	1.9	
Manufacture of apparatus for radio broadcasting,		0.0	
TV transmission & communication engineering	16	1.2	Longer time-frame (0.248)
Manufacture of medical & surgical instruments, and of scientific and measuring equipment	100	7.7	Longer time-frame (0.157)
Manufacture of transport equipment & parts	36	2.8	Longer time-frame (0.265)
Non knowledge-intensive (traditional) services	***145***	***11.2***	
Recycling, power- and water-supply	23	1.8	
Building trade and civil engineering	68	5.2	
Wholesale trade, retail trade, trade & repair of motor vehicles	23	1.8	
Tourism & hotel busineß	3	0.2	
Transport & traffic	10	0.8	
Sewage & rubbish disposal and other disposal	18	1.4	
Knowledge-intensive services	***365***	***28.2***	
News transmission, broadcasting, TV	6	0.5	
Credit & insurance agencies and allied services	1	0.1	
Software, data-processing and database	160	12.3	Longer time-frame (0.155)
Research & development	106	8.2	
Enterprise-related services	63	4.9	
Teaching, instruction & education	10	0.8	Time-frame (0.392); Riskier (0.688); more applied (0.616)
Health, veterinary medicine and social services	10	0.8	
Cultural industries, sports & entertainment	9	0.7	
Other branches/miscellaneous	72	5.6	
Missing industry affiliation	11	0.8	
TOTAL	**1296**	**100**	

Source: FFF-survey; [a)]Reference sector: Manufacture of metal products & parts

Table 6: Joint distribution of sector affiliation and firm-size

Sectoral affiliation	firm size as measured by the number of employees					Total
	<10	10-99	100-249	250 and more	missing	
Low-tech industries	51	110	65	77	7	310
R&D-intensive industries	110	149	55	71	8	393
Traditional services	63	48	10	18	6	145
Knowledge-intensive services	187	137	12	11	18	365
others/miscellaneous	31	28	6	5	2	72
Missing	4	2	1	1	3	11
Total	446	474	149	183	44	1,296

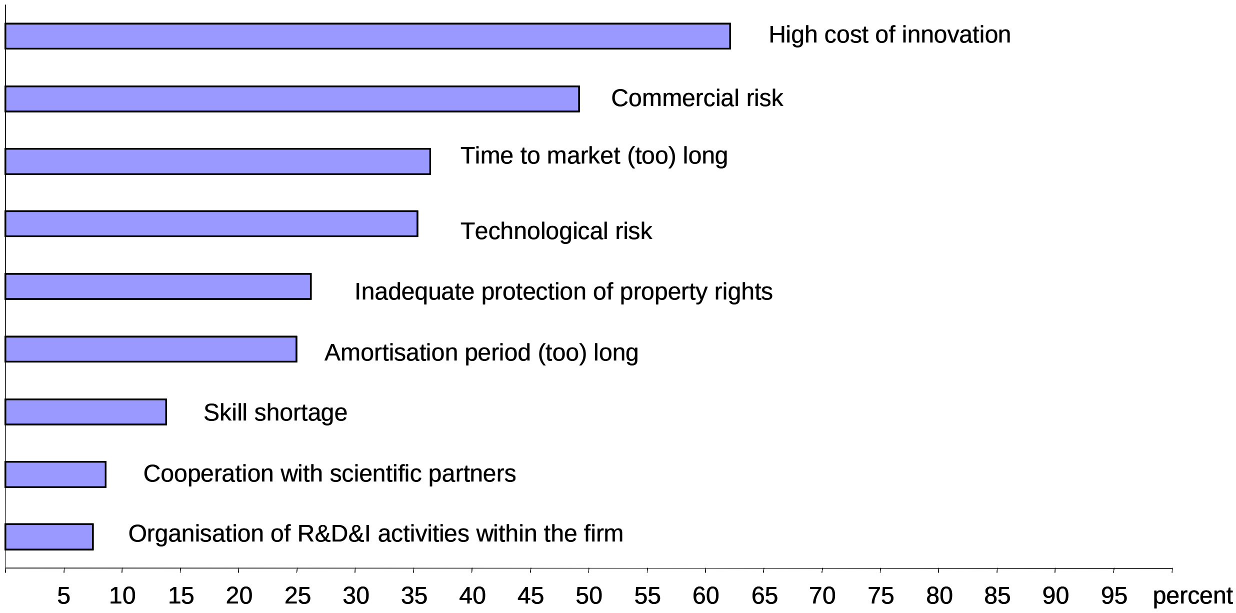
Source: FFF-survey

Table 7: Distribution of firm-size for newly founded and matured firms

Type of firm	firm size as measured by the number of employees				**Total**
	<10	10-99	100-249	250 and more	
Mature firms	25.06	41.53	15.56	17.85	100
Founded within the last 5 years	50.24	34.15	5.37	10.24	100
Total	29.84	40.13	13.62	16.4	100

Source: FFF-survey

Figure 3: Barriers to innovation



Source: FFF-survey

Table 8: Actual vs. hypothetical Project Additionalities: Detailed Analysis

	Analysis by firm-size		Analysis by sectoral affiliation		
	Hypothetical	Actual	Hypothetical	Actual	
Firm-size as measured by number of empl.	*Project is carried out without change (no project additionality)*				Sectoral affiliation
less than 10	8.4	14.08	18.52	34.02	low-tech manuf.
10 and more	13.4	19.15	13.02	23.61	high-tech manuf.
100 and more	18.82	42.31	15.12	18.75	traditional services
250 und more	22.35	26.97	7.89	12.12	knowl.-intens. Serv.
	Revised version of the project is carried out (partial project additionality)				
less than 10	50	47.18	58.2	46.39	low-tech manuf.
10 and more	60.14	43.97	62.33	47.92	high-tech manuf.
100 and more	57.65	44.23	47.67	41.67	traditional services
250 und more	64.71	51.69	57.37	47.73	knowl.-intens. Serv.
	Project is cancelled (full project additionality)				
less than 10	41.6	38.73	23.28	19.59	low-tech manuf.
10 and more	26.46	36.88	24.65	28.47	high-tech manuf.
100 and more	23.53	13.46	37.21	39.58	traditional services
250 und more	12.94	21.35	34.74	40.15	knowl.-intens. Serv.

Source: FFF; Details evidence from Table 1

References

Arrow, Kenneth J. (1962), Economic welfare and the allocation of resources for invention, in Richard Nelson (ed.), *The rate and direction of inventive activity: Economic and social factors*, pp. 609-625, Princeton University Press, Princeton, N.J.

Aslesen, Heidi W., Marianne Broch, Per M. Koch and Nils H. Solum (2001), User oriented R&D in the Research Council of Norway, Technopolis RCN evaluation, Oslo.

Branstetter, Lee G. and Mariko Sakakibara (2002), When do research consortia work well and why? Evidence from Japanese panel data, American Economic Review, Vol. 92,1, pp. 143-159.

Buisseret, Timothy J., Hugh M. Cameron and Luke Georghiou (1995), What difference does it make? Additionality in the public support of R&D in large firms, International Journal of Technology Management, Vol. 10, pp. 587-600.

Czarnitzki, Dirk, Bernd Ebersberger and Andreas Fier (2004), The relationship between R&D collaboration, subsidies and patenting activity: empirical evidence from Finland and Germany, ZEW Discussion Paper No. 04-37.

Davenport, Sally, Charlotte Grimes and John Davies (1998), Research collaboration and behavioural additionality: a New Zealand case study, Technology Analysis & Strategic Management, March 1998, pp. 55-67.

David, Paul A., Bronwyn H. Hall and Andrew A. Toole (2000), Is public R&D a complement or substitute for private R&D? A review of the econometric evidence, Research Policy, Vol. 29, pp. 497-529.

Dodgson, Mark and Roy Rothwell (eds.) (1994), *The handbook of industrial innovation*, Edward Elgar Publishing, Cheltenham.

Fagerberg, Jan, David C. Mowery and Richard R. Nelson (2004) *The Oxford handbook of innovation,* Oxford University Press, Oxford.

Falk, Martin (2004), Productivity effects of R&D subsidies: evidence from firm-level panel data, Tip Working Paper.

Fransman, Martin (1990), The market and beyond: cooperation and competition in information technology, Cambridge University Press, Cambridge.

Freeman, Chris (1994), The economics of technical change, *Cambridge Journal of Economics*, Vol. 18, pp. 463-514.

Garcia, Abraham and Pierre Mohnen (2004), Impact of government funding on R&D and innovation, Background Report to the European Competitiveness Report 2004, chapter 2.4.1.

García-Quevedo, Jose (2004), Do public subsidies complement business R&D? A meta-analysis of the econometric evidence, Kyklos, Vol. 57, 1, pp. 87-102.

Georghiou, Luke, (1997), Issues in the evaluation of innovation and technology policy, in: Policy evaluation in innovation and technology: towards best practice, chapter 3, OECD, Paris.

Georghiou, Luke and David Roessner (2000), Evaluating technology programs: tools and methods, Research Policy, Vol. 29, pp. 657– 678.

Georghiou, Luke, (2002), Impact and additionality of innovation policy, IWT-Studies No. 40, pp- 57-65.

Georghiou, Luke, Keith Smith, Otto Toivanen, Pekka Ylä-Anttila.,"*Evaluation of the Finnish innovation support system*", Ministry of Trade and Industry, 2003, Finland.

Gottschalk, Sandra and Norbert Janz (2003), *Bestimmungsfaktoren der Innovationstätigkeit*, in: Norbert Janz and Georg Licht (eds.), Innovationsforschung heute, ZEW Wirtschaftsanalysen, Vol. 63, Baden-Baden, 2003, pp.17-39.

Hyvärinen, Jari (2005), Measuring behavioural additionality effects of public R&D funding: A Study of Finland, Tekes Working Paper.

Klette, Tor J., Jarle Møen and Zvi Griliches (2000), Do subsidies to commercial R&D reduce market failure? Microeconometric evaluation studies, Research Policy, Vol. 29, pp. 471-495.

Luukkonen, Terttu (2000), Additionality of EU framework programmes, Research Policy, Vol. 29, pp. 711-724.

Metcalfe, Stan (1995), The economic foundations of technology policy: equilibrium and evolutionary perspectives, in Paul Stoneman (ed.), *Handbook of the economics of innovation and technological change,* Blackwell, Oxford.

Nelson, Richard R. (1959), *The simple economics of basic scientific research*, Journal of Political Economy, 67, pp. 297-306.

OECD (2005), The behavioural additionality of R&D grants: introduction and preliminary synthesis, OECD Working Party on Innovation and Technology Policy.

Papaconstantiou, George and Wolfgang Polt (1997), Policy evaluation in innovation and technology: an overview, in: Policy evaluation in innovation and technology: towards best practice, chapter 1, OECD, Paris.

Pegler, Bob (2005), Behavioural additionality in Australian business R&D grant programs, Paper presented at the OECD Workshop on Behavioural Additionality in Vienna, January 2005.

Rigby, John (2003), ASIF: Evaluating socio-economic impact, Plattform Forschungs-und Technologieevaluierung No. 17 (March 2003), pp. 13-17.

Schibany, Andreas, Gerhard Streicher, Nikolaus Gretzmacher, Martin Falk, Rahel Falk, Norbert Knoll, Gerhard Schwarz, Martin Wörter (2004), Evaluation FFF – Impact analysis, InTeReg Research Report Series No. 22-2004. Download: http://www.joanneum.ac.at/cms_img/img2082.pdf

Sakakibara, Mariko (1997), Evaluating government-sponsored R&D consortia in Japan: who benefits and how, Research Policy, Vol. 26, pp. 447-473.

Shipp, Stephanie, Lorel Wisniewski, Andrew Wang, and Steve Campbel (2005), Measuring behavioral additionality in ATP joint venture projects: Findings from the U.S. Advanced Technology Program, Paper presented at the OECD Workshop on Behavioural Additionality in Vienna, January 2005.

Stoneman, Paul and John Vickers (1988), The assessment: the economics of technology policy", *Oxford Review of Economic Policy*, Vol. 4, pp. 1-16.

Streicher, Gerhard, Andreas Schibany and Nikolaus Gretzmacher (2004), Input additionality effects of R&D subsidies: empirical evidence from firm-level data, TIP Working Paper, Mach 2004.

Sundbo, Jon (1998), *The Theory of Innovation: entrepreneurs, technology and strategy*, Edward Elgar Publishing, Cheltenham.

Tether, Bruce (2003), The sources and aims of innovation in services: variety between and within sectors, Economics of Innovation and New Technology, Vol. 12, 6, pp. 481-505.

Wong, Poh-Kam and Zi-Lin He (2003), the moderating effect of a firm's internal climate for innovation on the impact of public R&D support programmes, International Journal of Entrepreneurship and Innovation Management, Vol. 3, pp. 525-545.

Medieninhaber (Verleger), Hersteller: Österreichisches Institut für Wirtschaftsforschung • Wien 3, Arsenal, Objekt 20 • A-1103 Wien, Postfach 91 • Tel. (43 1) 798 26 01-0 • Fax (43 1) 798 93 86 • http://www.wifo.ac.at/ • Verlags- und Herstellungsort: Wien

Die Working Papers geben nicht notwendigerweise die Meinung des WIFO wieder

Verkaufspreis: EUR 8,00 • Download kostenlos:
http://publikationen.wifo.ac.at/pls/wifosite/wifosite.wifo_search.get_abstract_type?p_language=1&pubid=25914