Socioeconomic benefits from user-driven innovation projects funded by the Research Council of Norway

The following presentation emphasizes various sets of indicators to support a socioeconomic evaluation of user-driven innovations projects. The sets of indicators focus on wider impacts from industrial research and development (R&D) projects.

User-driven Innovation Projects (BIP) represent one of the Research Council's most important funding instruments for promoting industrial research and innovation. This instrument constitutes a part of an overall public policy system to increase research-based value creation in Norway. The greater part of the annual government budget appropriation to R&D (23 billion NOK in 2010) funds R&D in universities and colleges where basic scientific research generally takes place. In Norway we also have a large number of research institutions that carry out R&D commissioned by the industry. User-driven research is part of a broader innovation system to provide incentives for companies to cooperate with research institutions on R&D projects that reflect the strategies and knowledge needs of the companies. An argument for public support of scientific research in universities as well as user-driven R&D is market imperfections with focus on externalities. The indicators presented in this report illustrate the degree of externalities in user-driven projects; however they will also have the effect of increasing the externalities in the more basic research oriented systems. In designing a broad public policy system it is important to harmonize the policy instruments as discussed in the Official Norwegian Report 2000:7 "A new deal for innovation."

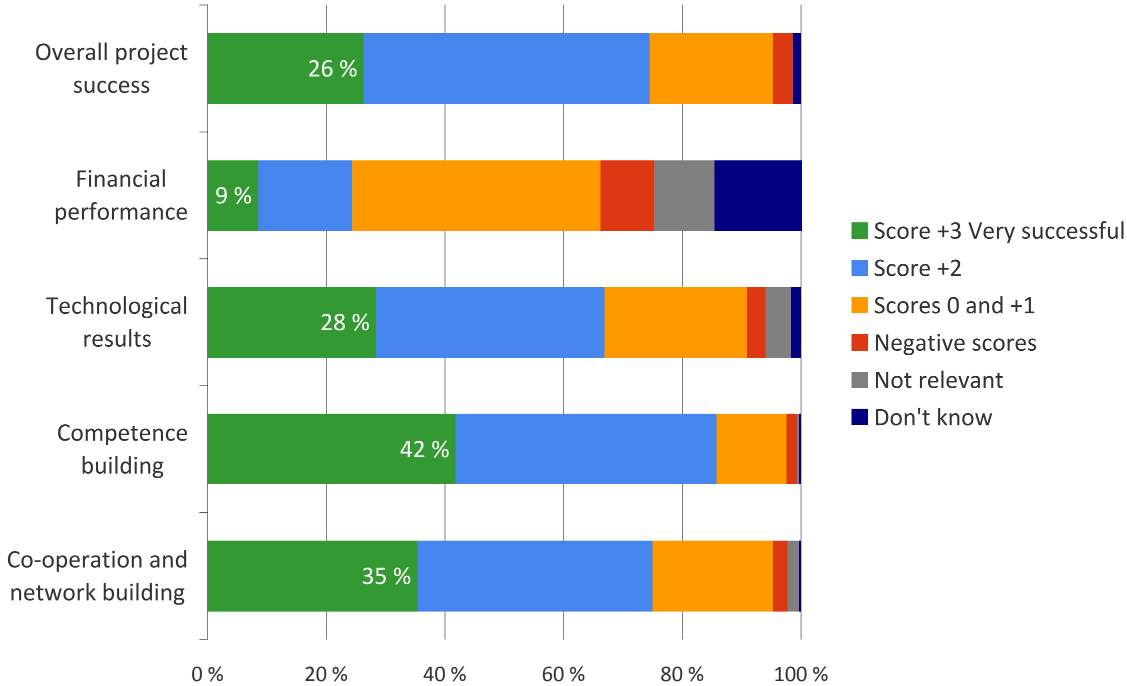
In the following we first present various indicators for internal success in the companies that are users of knowledge created in the user-driven innovation projects. This is followed by indicators of additionality to examine the counterfactual problem, what would happen in the absence of the Research Council's funding support. The third set of indicators estimates private returns based on interview data following the R&D projects from start-up to finalization and long-term measurements four year after completion. The fourth set of indicators focuses on externalities and the wider impacts creating economic benefits outside the supported companies. Finally we put together the four sets of indicators to summarize the socioeconomic impacts from the user-driven innovation projects. It is not possible to determine the social return in one figure and we choose to make an assessment based on the four sets of indicators.

The various indicators presented are based on extensive surveys carried out annually over many years where the companies (the contractual partners with the Research Council) are interviewed on project basis at start-up, finalization and four years after completion. Each year 250-300 interviews are carried out, and as of today we have gathered 2 200 observations divided between the three points in time.

Internal company success

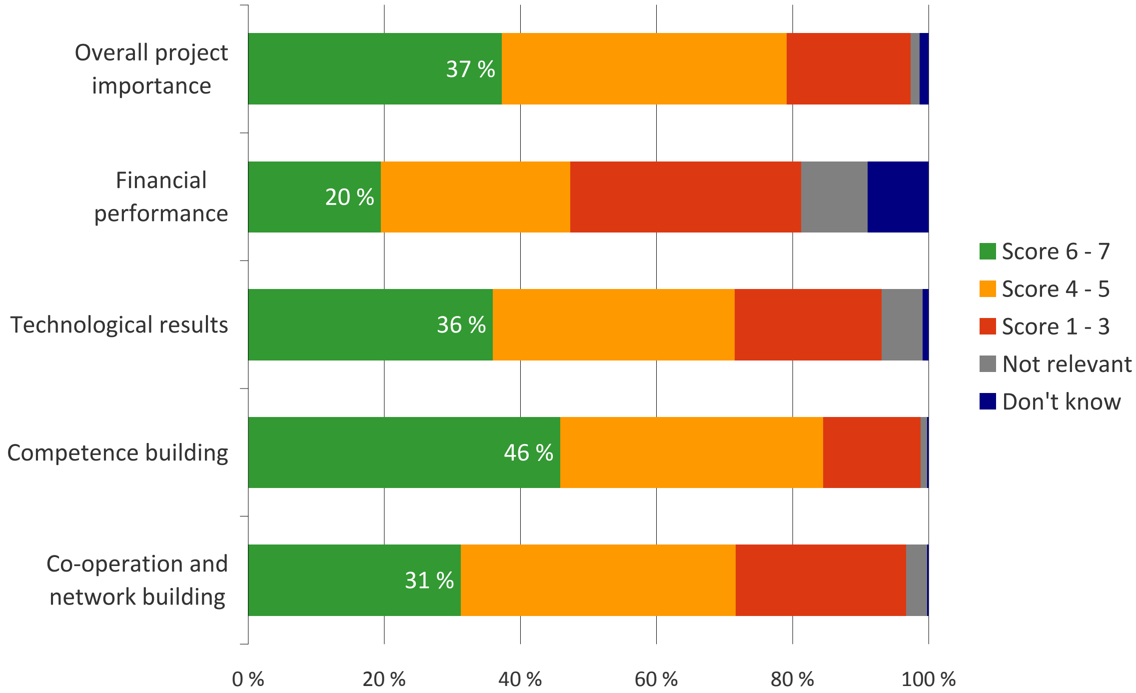
At the finalization of the R&D projects the companies are asked to evaluate the success of their projects on five indicators including teamwork, competence building, technological results, financial performance and overall success. The indicators are measured on a scale from -3 “very unsuccessful” to +3 “very successful.” For overall performance 26 % of the projects are considered to be very successful, see Figure 1. 9 % of the projects are considered to be very successful when it comes to financial performance. 42 % of the projects are given the highest score for competence building and 35 % are considered to be very successful regarding teamwork and network building. The companies indicate that there are other results besides financial performance that are important for the success of their projects.

Figure 1 Assessment of project success at finalization, completed user-driven innovation projects 2000-08.



After completion of the R&D projects the companies are also asked to evaluate the importance of the project to the development of their own company. The question includes the same five indicators as above using a scale where score 1 is “not important at all” and score 7 is “very important.” Overall, 37 % of the projects were considered to of great importance (score 6 and 7) for company development, see Figure 2. 20 % of the projects were considered of great importance to financial development in the companies, and 46 % are of great importance for the development of expertise within the companies.

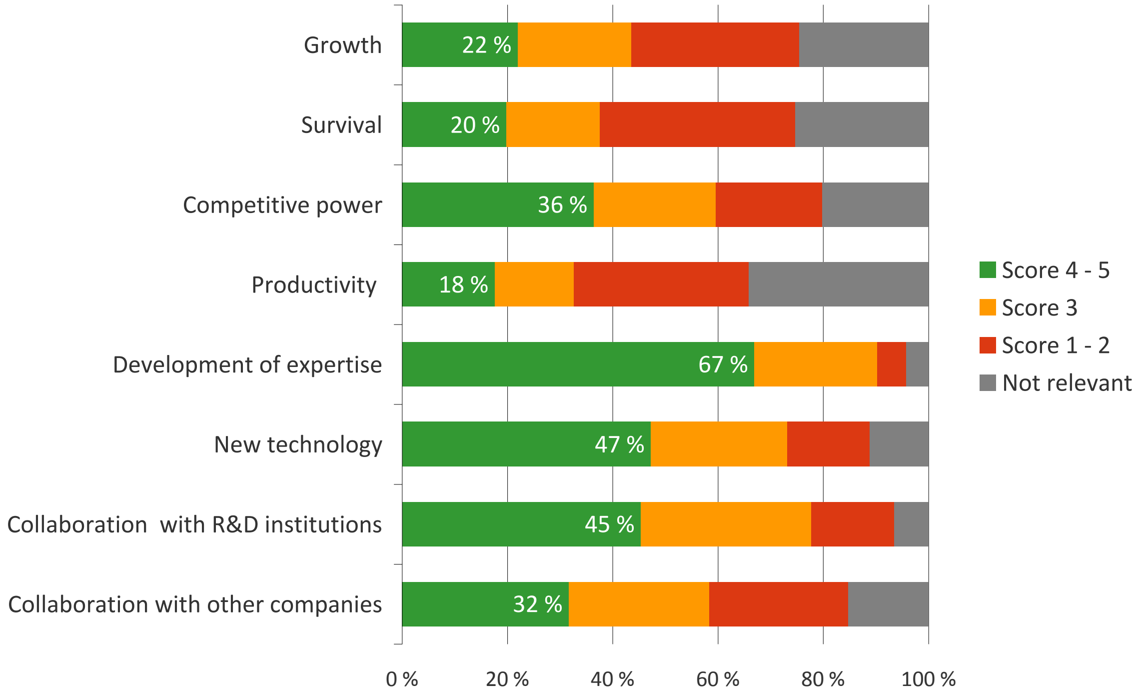
Figure 2 Importance of the R&D project to company development, completed user-driven innovation projects 2000-08.



Four years after completion of the R&D projects the companies are asked again to evaluate the importance of their project for eight different indicators relating to the development of the company. The scale used in this question was from score 1 “not important” to score 5 “very important.” Figure 3 show that 67 % of the projects are considered to be of great importance (score 4 and 5) for the development of expertise within the company. 47 % of the projects are of great importance to the development of new technology and 45 % are of great importance for the development of co-operation with R&D institutions. 36 % of the projects were considered to be of great importance for the development of long-term competitive power, while less significance are placed on productivity, company growth or survival.

The indicators for internal company success show that most projects are considered successful, primarily related to the development of expertise and competence building and less important for the development for financial performance.

Figure 3 Importance of the R&D project to company development, completed user-driven innovation projects 1996-2005 measured four years after.



Additionality

The counterfactual problem is of great importance to evaluate the accuracy of the public funding. The subjective indicators for the measurement of input and behavioural additionality are in our experience more robust than often assumed. Measurements of input additionality indicate that about half of the projects would not be realized without the public funding, see Figure 4.

When the companies are asked how the Research Council funding influences their R&D activity we find that the public funding to a great extent (score 6 and 7) contributes to the realization of 67 % of the projects, see Figure 5. In 47 % of the projects the companies think the public support greatly influences co-operation with R&D institutions, and 32 % emphasizes the influence on cooperative research with other companies. The Research Council's funding is important for the realization of half of the projects studied, and has a positive influence on R&D activities with the development of network building and co-operation, and also the scope and size of the projects.

Figure 4 Assessment of input additionality, user-driven innovation projects with start-up 1995-2008.

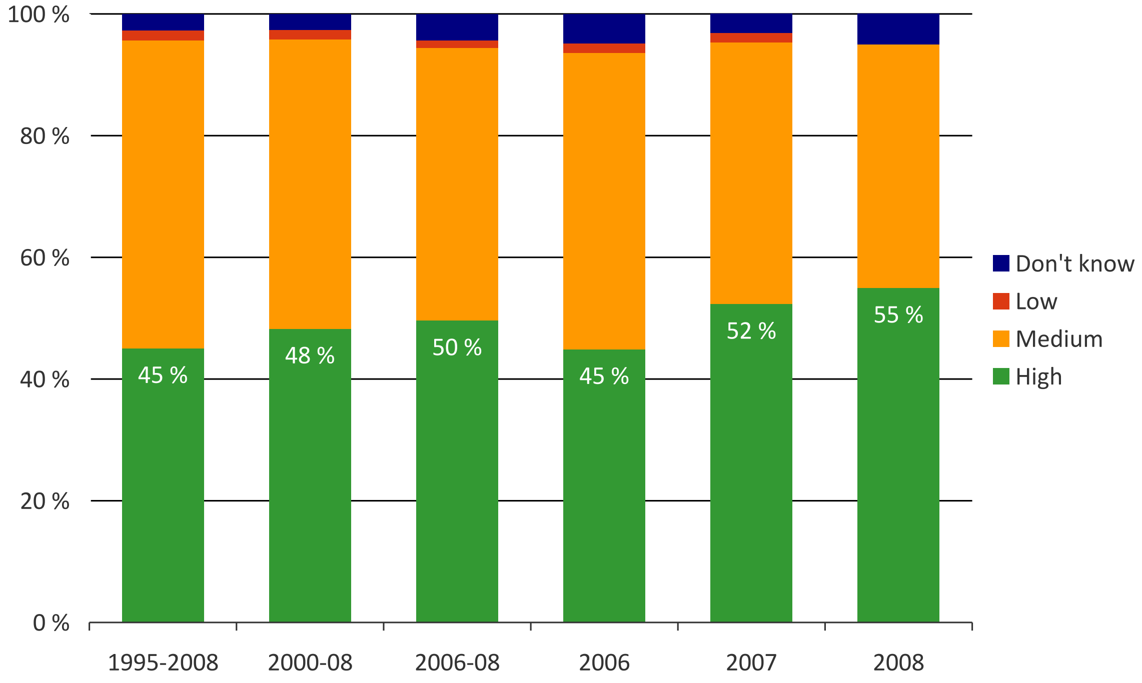
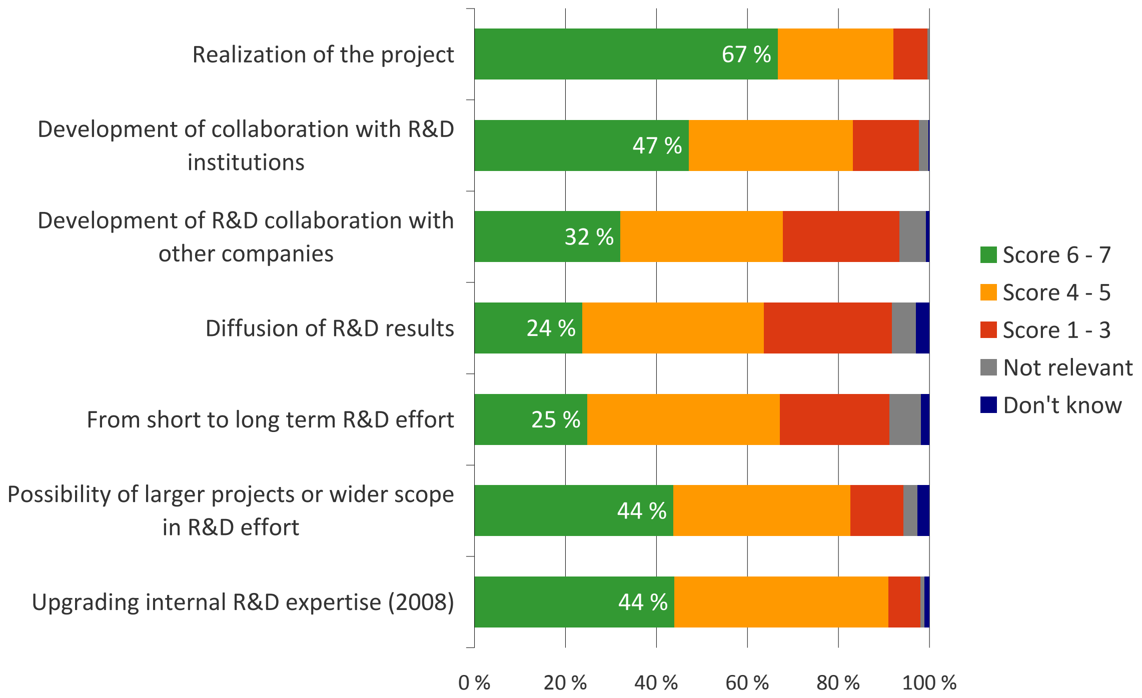
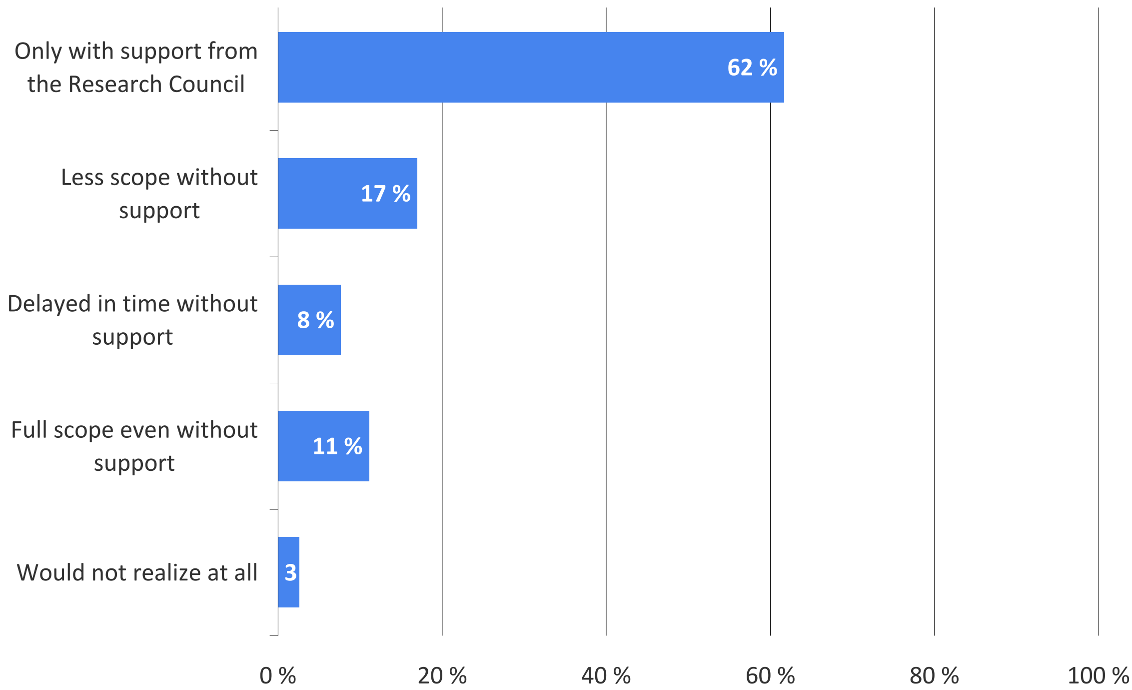


Figure 5 Assessment of behavioural additionality, user-driven innovation projects with start-up 2000-08.



When the R&D projects are completed the companies once again indicates that 62 % of the projects would only be realized with the support of the Research Council. Another 25 % of the projects could in retrospect be realized without such support, but then in a smaller scope or delayed in time.

Figure 6 Assessment of project realization in retrospect, completed user-driven innovation projects 2000-08.



Private returns

The companies are challenged to quantify private returns resulting from the R&D projects at start-up, finalization and four years after completion. The companies' financial estimates indicate great optimism at start-up and that for many projects these estimates are adjusted downward to a great extent in the long-term measurements four years after completion. We have followed 709 projects completed in the period 1996-2005 through all three phases and find an estimate for total expected private returns of 20 billion NOK (calculated as net present value for 226 projects were the companies have provided financial estimates). In this group of projects the net present value is adjusted down to 8.4 billion NOK in the long-term measurement four years after completion. For the remaining 483 projects no estimates for private returns were provided at start-up; however in the long-term measurement 67 of these projects are providing financial estimates with a net present value of 4.3 billion NOK.

For the 709 projects studied here a total estimate for private returns in the long-term measurements, calculated as net present value, are in the order of 12.7 billion NOK. This net present value also include the R&D expenditures of the companies and the public funding totalling 6.9 billion NOK, indicating a high rate of return on the R&D efforts. Still, most of this return is based on expectations of future earnings, and about 80 % the calculated long-term net present value is related to only 19 R&D projects.

Figure 7 show the companies' expectations regarding private returns for new R&D projects with start-up in 2008 along with the assessment of the expert panel for the same projects in the pre-evaluation process. According to the companies interviewed 42 % of the projects are expected to have a private return at a level considered the norm in the industry which the companies operate, and assuming commercial success. In the pre-evaluation process 24 % of the projects were expected to have a similar level of private returns. The companies believed that about 45 % of the projects could be more profitable than the norm in their industry, while 65 % of the projects had the same expectations in the pre-evaluation process.

Figure 7 Expectations of private returns to R&D projects, user-driven innovation projects with start-up in 2008.

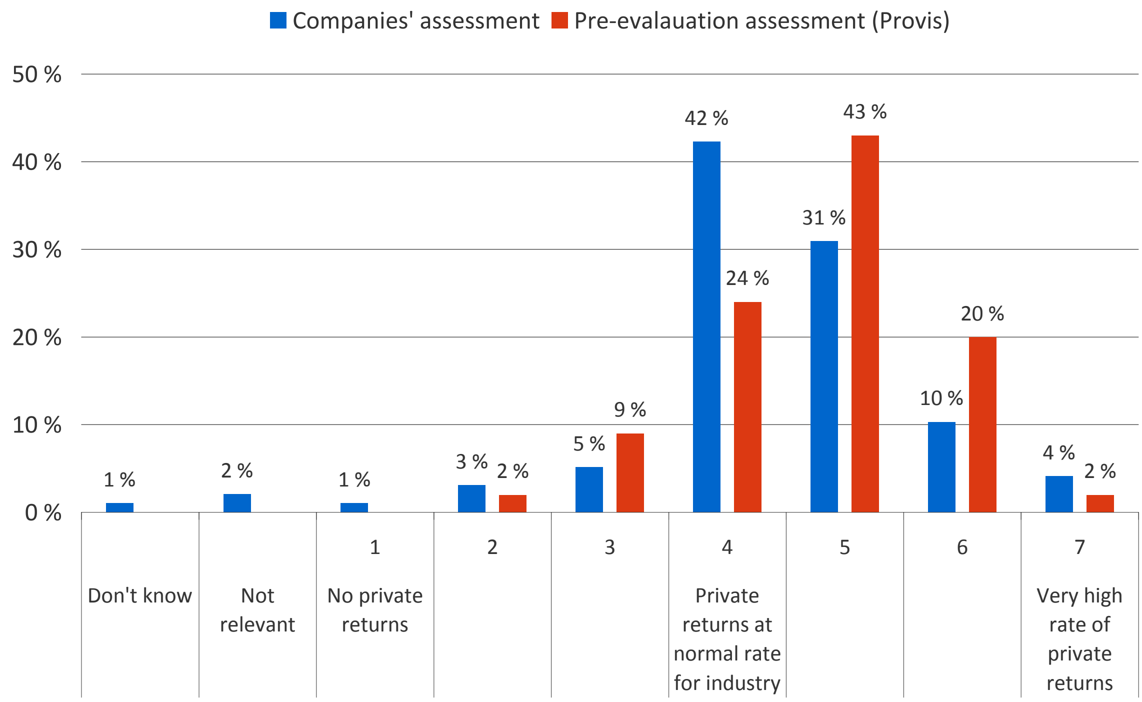
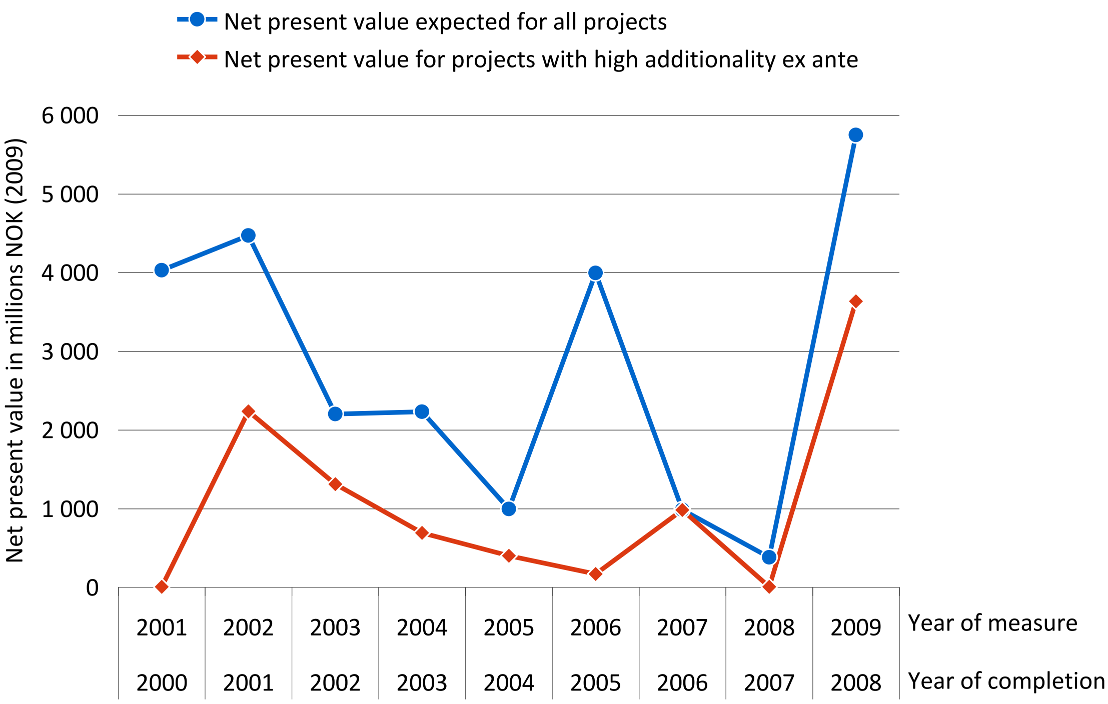


Figure 8 show calculated net present value for User-driven Innovation projects that were completed in the years 2000-08 based on actual results and estimates of future earnings at the time of completion. Total net present value for 201 projects in this period is 25 billion NOK with large variation between years. Projects ended in 2008 have a total net present value of 5.7 billion NOK based on average expectations, however with a low estimate of 1.4 billion and high estimate of 9.4 billion NOK. Adjusted for input additionality, as reported by the companies at start-up, the net present value of 25 billion would be brought down to 9.5 billion NOK.

The survey that was carried out in 2008 took place before the global impact of the recent financial crisis, but prior to an expected recession that reflects the low estimates on private returns that year. The latest survey took place early in the second half of 2009 and despite the financial crisis, and great uncertainty about the economic conditions, the measured return is at an all time high for the period here covered. Also, when adjusted for input additionality the adjustment downward is relatively small.

Figure 8 Calculated net present values based on estimates from companies at finalization, completed user-driven innovation projects 2000-08.



The survey in 2009 for long-term evaluation of projects completed in 2005 show that 48 % of the projects had resulted in commercial products or implementation of industrial processes. For an additional 24 % of the projects the companies were expecting commercialisation of results within two to five years, see Figure 9.

Calculated net present value for projects ended in the years 1996-2008 based on estimates four years after completion is shown in Figure 10. The sum of long-term private return for all projects in this period is 12.7 billion NOK, with large variation between years and the measurements of the last two years seems to capture the general economic trends with low net present values. Adjusted for input additionality reported by the companies at start-up the estimate is reduced from 12.7 billion to about 4 billion NOK.

Figure 9 Plans for commercialization of R&D results four years after finalization, completed user-driven innovation projects 2005.

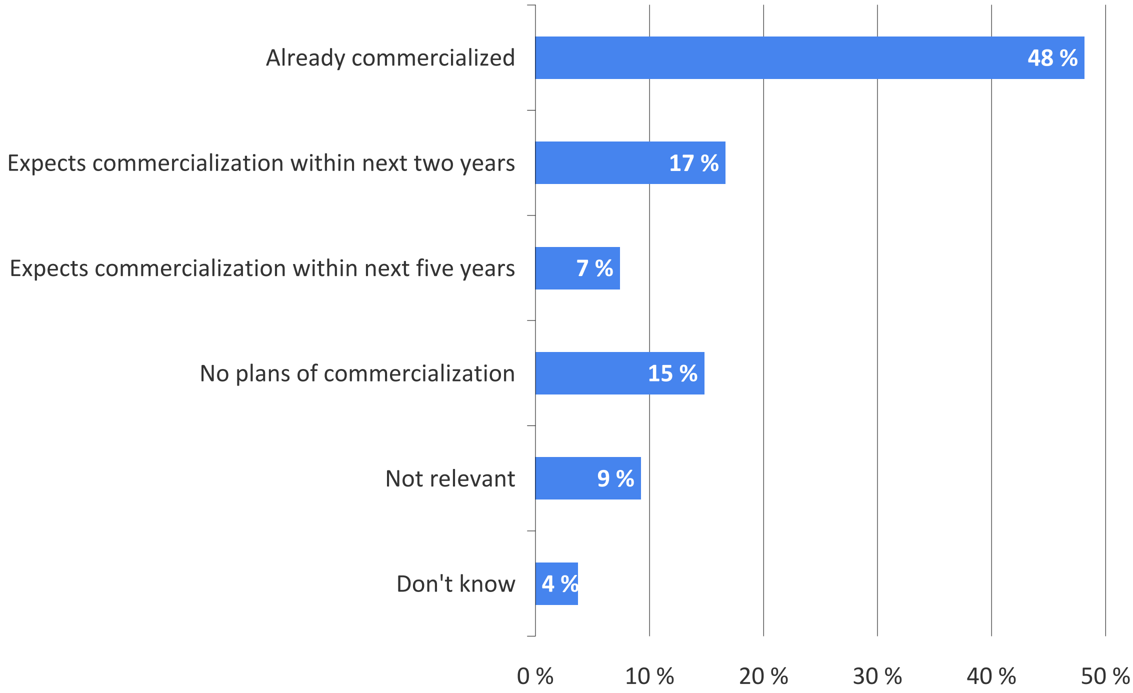
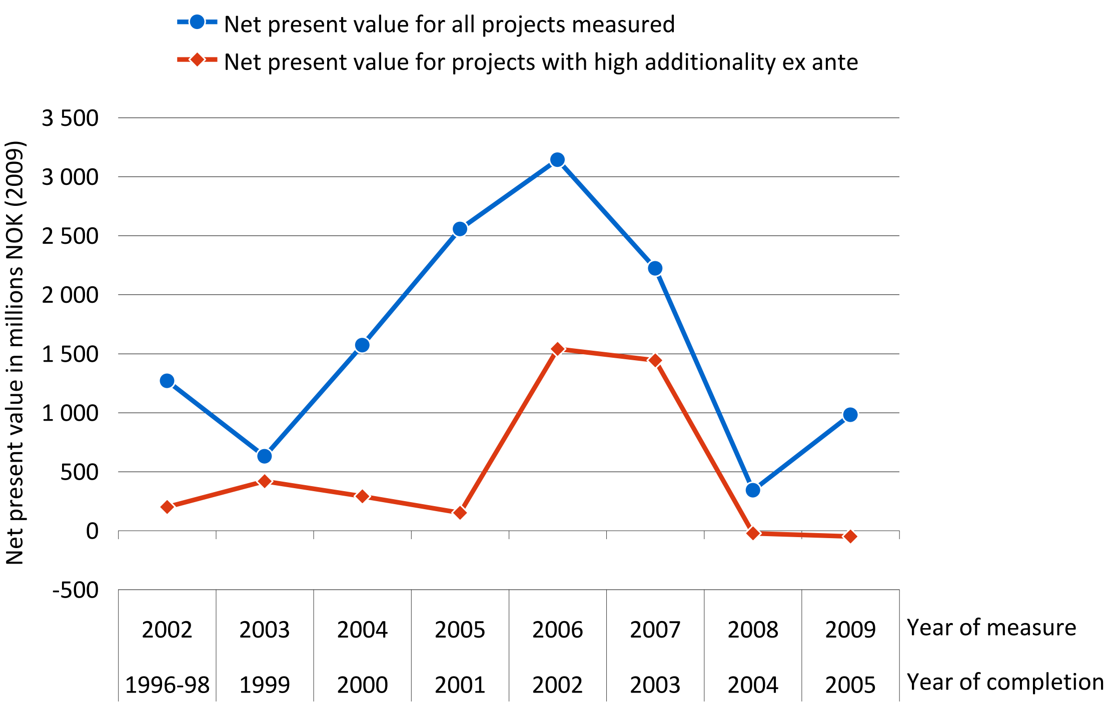


Figure 10 Calculated net present values based on estimates from companies four years after finalization, completed user-driven innovation projects 1996-2005.

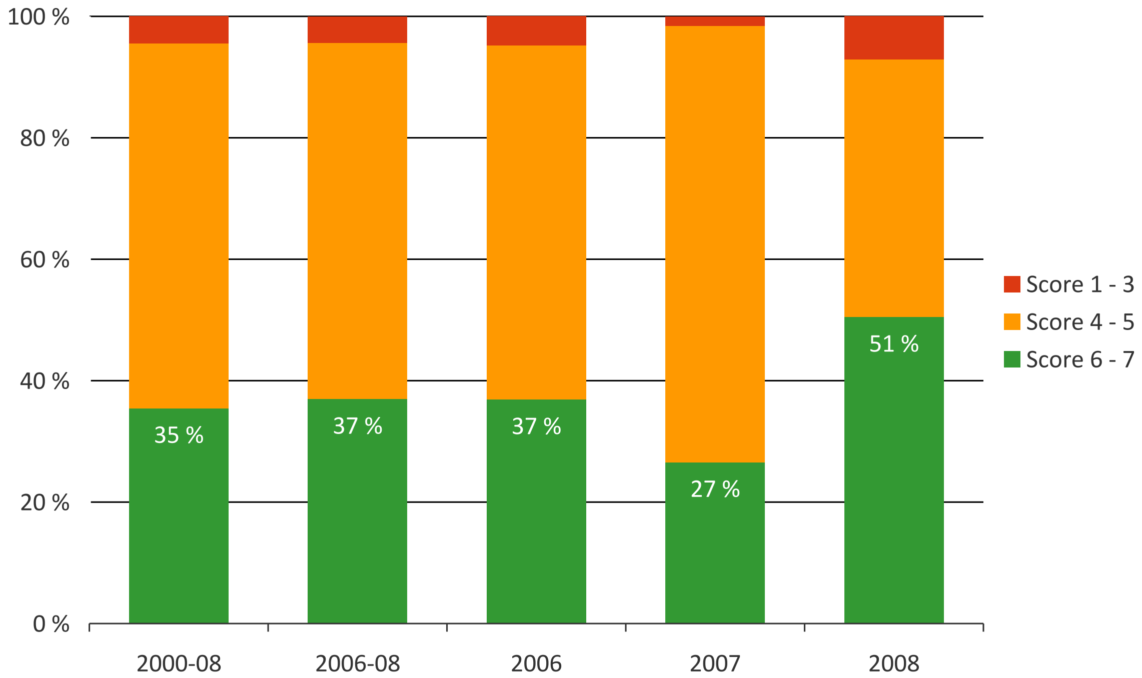


Externalities

The diffusion of knowledge and technology results from R&D projects is important indicators of external effects. The companies think that about 20 % of the projects results in socially useful products, and that 40 % of the projects have spillovers in terms of competence building. Important indicators to follow the development and diffusion of knowledge are doctorates, publishing in scientific journals, the scope of innovation, novel goods and services, and new cooperative networks in the R&D system. All indicate a potential of creating spillovers.

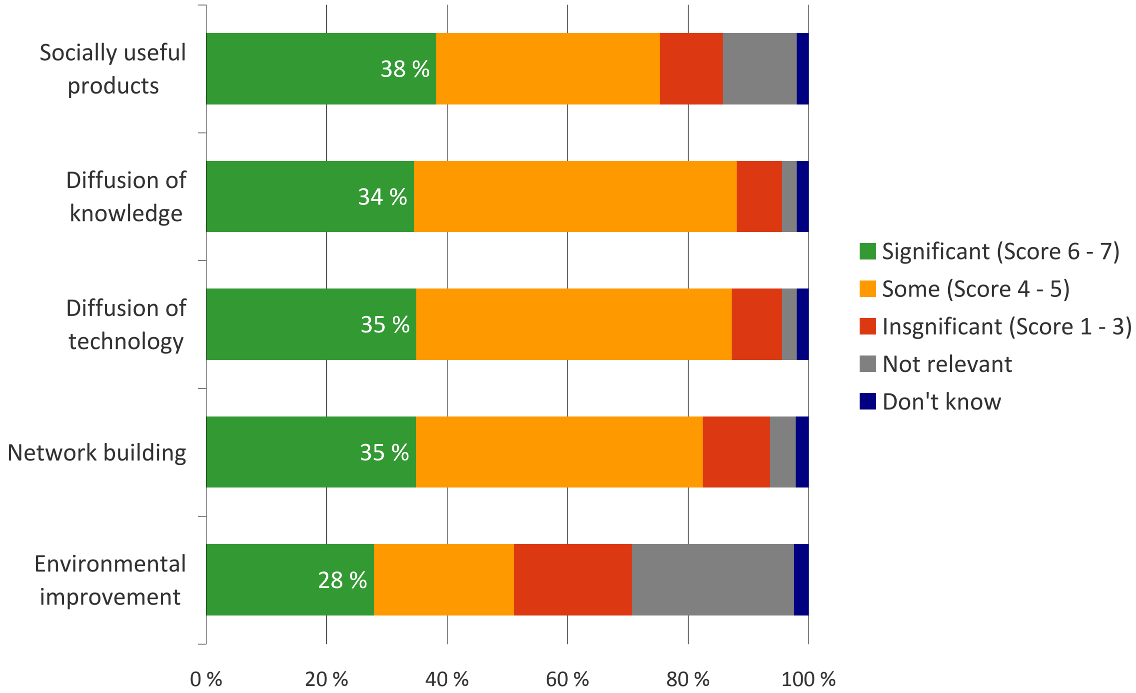
The level of scientific and explorative work in the R&D projects also indicates the potential of spillovers, and Figure 11 shows how the companies themselves evaluate the R&D efforts in their projects. For projects with start-up in the years 2000-08 the companies assessed 35 % of the projects to be leading-edge or at the international forefront (score 6 and 7), and 60 % are applied research (score 4 and 5). For projects completed in 2008 the companies report 51 % to at the higher end of the scale, while the pre-evaluation in the selection process indicate that 34 % has the equivalent high research content.

Figure 11 Assessment of R&D content, user-driven innovation projects with start-up in 2000-08.



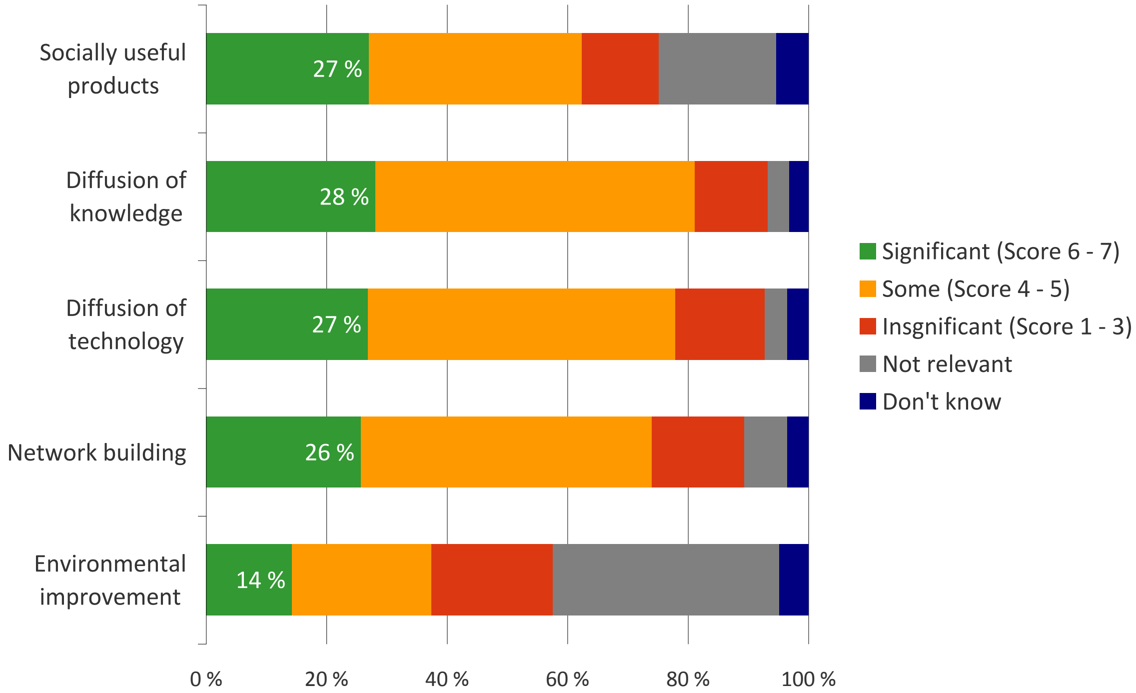
At start-up the companies are asked to assess the socioeconomic benefits of their projects for various indicators, see Figure 12. In the years 2002-08 companies believed that 38 % of the projects could significantly contribute to socially useful products. In addition they expected significant effects regarding diffusion of knowledge and technology, and network building in about one third of the projects. Considerable environmental improvement was expected as results in 28 % of the projects.

Figure 12 Assessment of socioeconomic benefits at start-up, user-driven innovation projects with start-up in 2002-08.



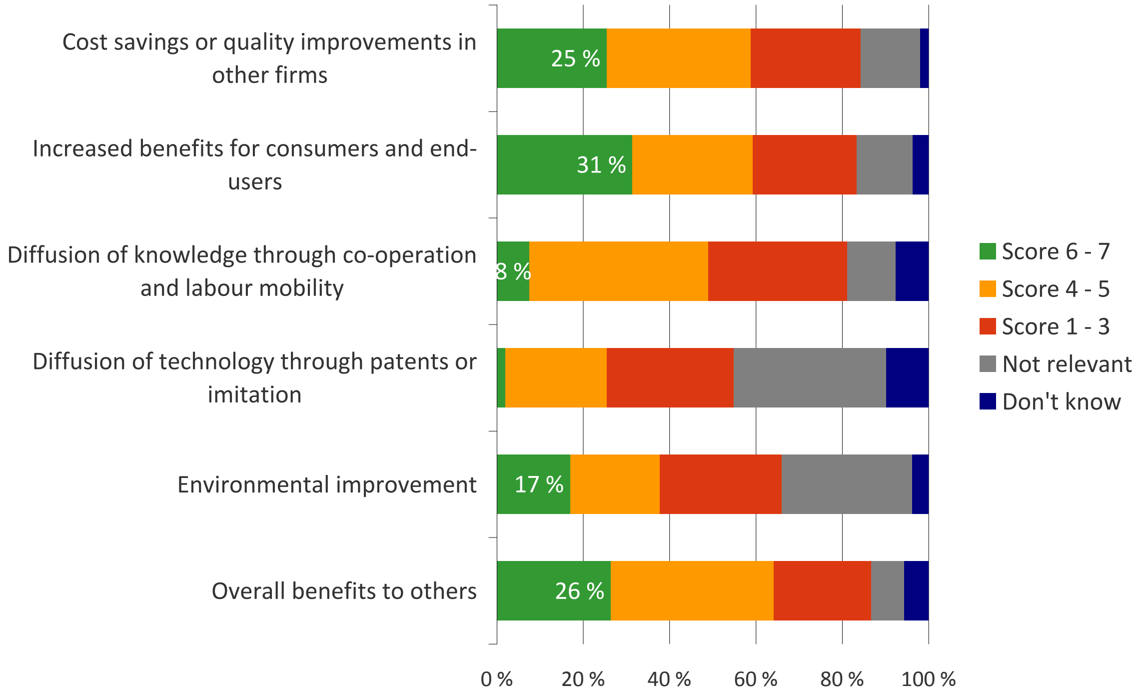
At completion the companies are once again asked to assess the socioeconomic benefits from the projects. The shares of significant effects for the various indicators are somewhat lower compared to the assessments at start-up. Figure 13 show that the companies expect significant effects in 26-28 % from the projects for most of the indicators, except for environmental improvements where 14 % of the projects have significant potentials.

Figure 13 Assessment of socioeconomic benefits at finalization, completed user-driven innovation projects 2000-08



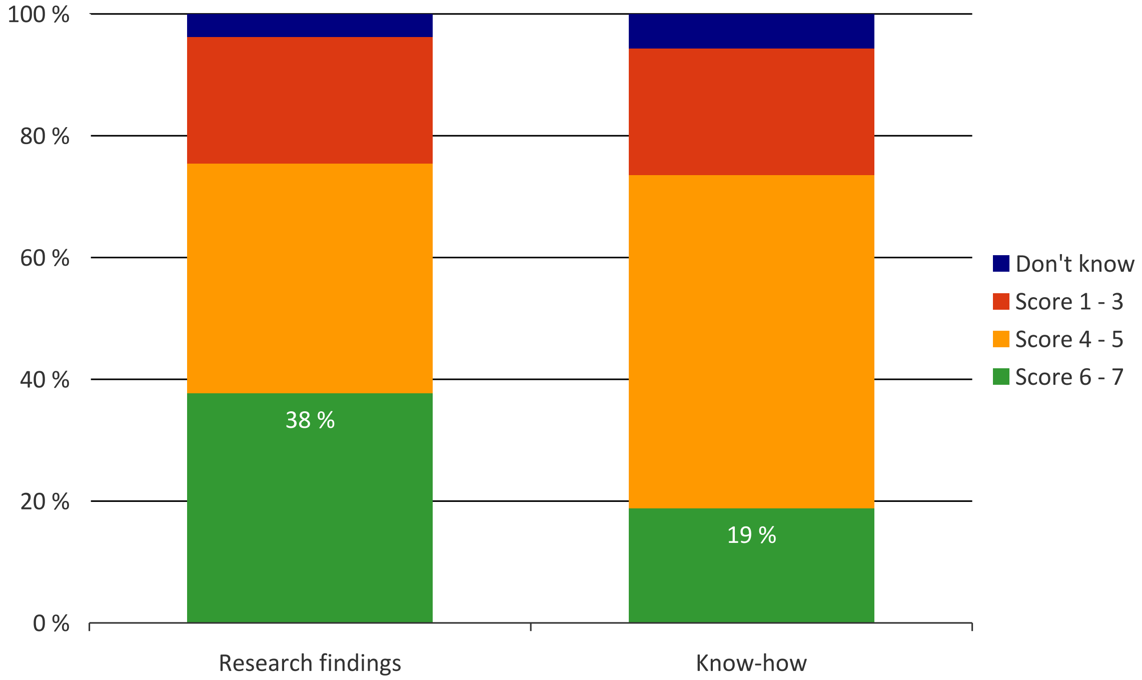
In the survey carried out in 2009 for projects completed in 2005 the companies where requested to assess different spillover effects based on the R&D results. Figure 14 show that 31 % of the projects contributes to great benefits (score 6 and 7) for end-users. Also, 25 % of the projects significantly contribute to cost savings or improved quality in other firms. In addition the companies believe 17 % of the projects have significant positive impacts regarding environmental improvement. Spillovers related to the diffusion of knowledge and technology do not have the same high shares of significant impacts, however with score 4 to 7 about half of the projects have impacts in terms of knowledge diffusion and 25 % through technology diffusion. The companies' overall assessment of benefits for others is significant in 26 % of the projects. This suggest that, from companies' perspective, there are significant spillovers that mainly benefits end-users and consumers or as cost savings and quality improvements in other firms.

Figure 14 Assessment of socioeconomic benefits four years after finalization, completed user-driven innovation projects 2005.



The companies were also asked to assess to what degree research results and know-how developed in the projects are known outside the companies and their cooperative partners. Figure 15 show that formalized research findings to a great extent is known to others in 38 % of the projects, and that know-how acquired from experience and practice to a great extent is know to others in 19 % of the projects. The indicators illustrated in Figure 15 are the type of externalities most often referred to as "pure" spillovers, while Figure 14 attempts to illustrate more of the pecuniary effects and the companies seem to be better informed about the latter effects.

Figure 15 To what extent is research findings and know-how from the project known to others, completed user-driven innovation projects 2005 measured in 2009.



From the indicators employed in our surveys that are related to externalities we conclude that some 20-30 % of the projects have the potential to generate such effects, however, the set of indicators are not to robust to make any assertive conclusions. Continuous analyses, the development of new indicators and in-depth case studies could contribute to accomplish more specific measures of impact. Estimates of externalities have methodically been tested in the evaluation of the Norwegian R&D tax credit scheme "Skattefunn" carried out by Statistics Norway. This is now being continued in a project where the experience from Møreforsking in the empirical surveys of user-driven R&D and the evaluation of the tax credit scheme is the basis for quantifying spillovers.

Socioeconomic impacts

Figure 16 illustrates how private and social returns to R&D are generated through market spillovers and knowledge spillovers, and the interaction of the two. The R&D investment of Firm 1, assuming successful commercialization, results in improved product quality or lower production costs. Depending on market competition, some of the improvements are captured by its customers causing a spillover gap equal to the customer benefit. Knowledge spillovers are indicated by downward arrows as new knowledge flow to other companies through publication of papers or patents, or as knowledge embodied in new products and processes. Competitors of Firm 1 that benefit from the knowledge spillovers could gain profits from introducing better or cheaper products, and create additional customer benefits as indicated by the upward arrow. Other firms could also take advantage of the knowledge spillover to create improved or cheaper products and processes in their own market, resulting in firm profits and customer benefits.

Figure 16 Illustration of private and social returns to R&D, Source: NIST GCR 03-857.

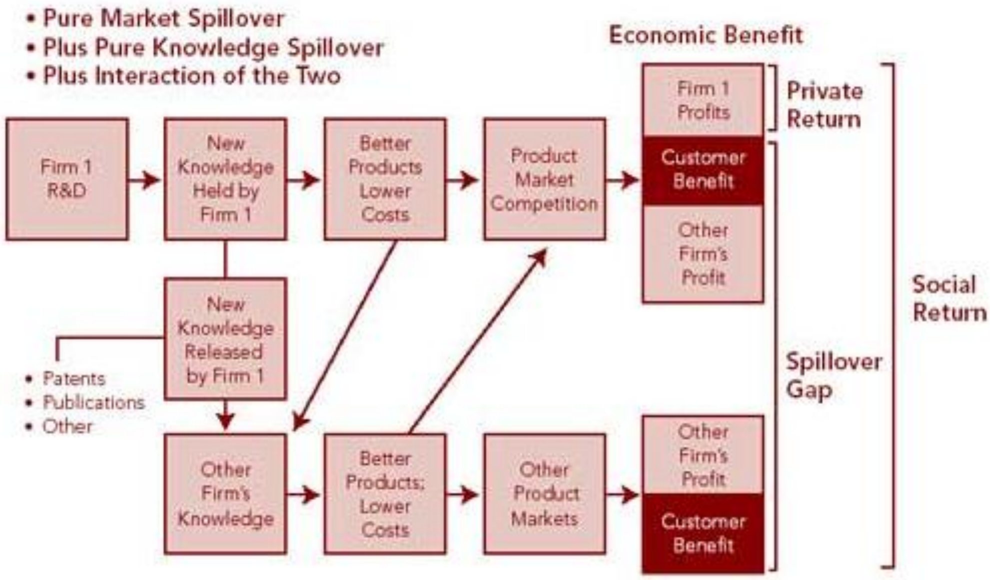
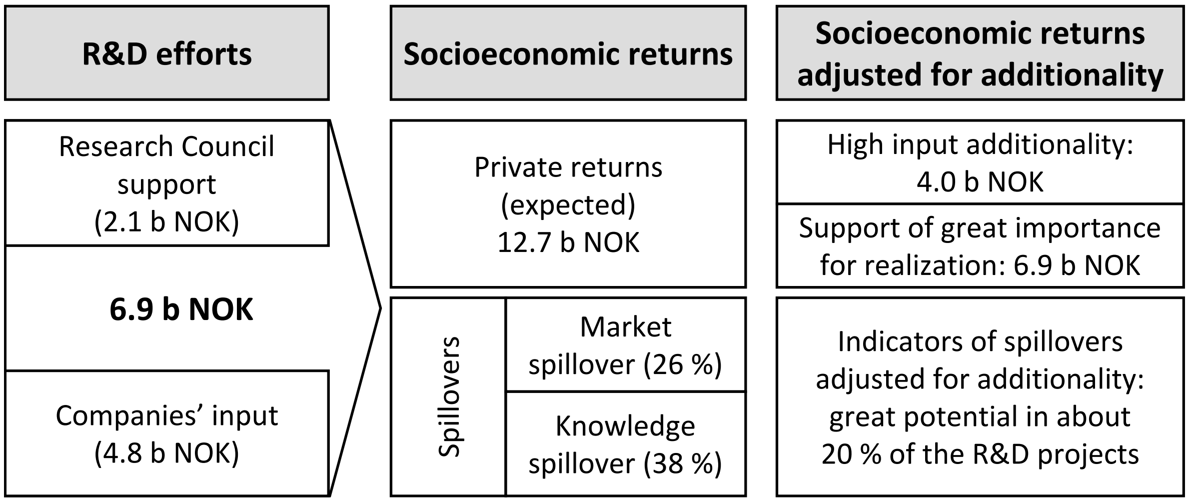


Figure 17 illustrates the main perspective on effects that justifies why the Research Council should support user-driven R&D. Total research input in 709 projects competed in the years 1996-2005 was 6.9 billion NOK of which the contribution from the Research Council amounted to 2.1 billion. The private returns measured four years after completion is calculated to a net present value of 12.7 billion NOK. Adjusted for input additionality the net present value is 4 billion, and a second measure for additionality implies a net present value of 6.9 billion NOK. The market spillovers, or pecuniary effects, and the "pure" knowledge spillovers cannot be quantifies in monetary terms. Based on the empirical findings we find that one out four projects have significant market spillovers, and significant knowledge spillovers in about 40 % of the projects studied. Adjusted for additionality we estimate significant spillovers in about 20 % of the projects. The accumulated effect from the 709 projects studied in long-term evaluations suggest that there are many good projects with high private returns and with positive effects on knowledge building in the companies, and also many with considerable external effects. Overall, we conclude that social returns to user-driven R&D seem to be satisfying.

Figure 17 A main perspective on the measure of social returns to user-driven innovation projects, collected R&D efforts and the effects of 709 projects finalized in the years 1996-2005 and measured four years after completion.



Selection of R&D projects for public support

In 1999 the Research Council implemented a selection tool, Provis, to assist the decision of which project candidates to support. For User-driven Innovation projects (BIP) a set of eleven attributes or indicators are evaluated, in which five attributes are evaluated by a panel of experts (peer review). Analyses of Provis show that the attribute "Project quality" has a large and increasing importance over time in determination of "Total score". The attributes "Research content" and "Relevance for program" are also weighted heavily in the determination of the total score. All attributes have significant explanatory power for project support, and the selection tool is actively used in the decision process.

A comprehensive analysis of Provis with emphasis on private returns, spillovers, risk and additionality indicate that the selection, to a reasonable extent, fulfil the theoretical reasons for public support. A theoretical framework for project selection (Jaffe, 1998) focuses on spillovers and private returns in the selection of commercial R&D for public support. In Provis the potential for private returns and spillovers are evaluated for each proposal. Table 1 cross tabulates the two attributes for proposals that were refused or granted support in the years 2006-08. The table shows that 64 % of the approved proposals were expected to achieve private returns (score 4 and 5) at a level considered the normal in the line of business associated with R&D project, and with some or significant spillovers (score 4-7). These "green" project proposals are from the theoretical point of view the most eligible candidates for support. We also note that a large share of the refused proposals (54 %) have the same evaluation in Provis.

Among the approved proposals, we find that 23 % are expected to obtain large private returns (score 6 and 7) and also some or significant spillovers. These "yellow" project proposals would in the theoretical perspective be considered as highly profitable and therefore most likely to be carried out even without public support. However, the attribute for private returns (A5) is not risk-adjusted but based on expected successful commercialization. Such a risk-adjustment would still make some of the proposals relevant candidates for support.

Among the rejected proposals we find 40 % having insignificant (score 1-3) expectations for both private returns and spillovers. The “red” project proposals would in theory be poor candidates for support, and on the positive side we find that many of the proposals in this group that are rejected and quite few that are granted support. Another positive aspect is that a greater share of the approved proposals is expected to have large spillovers than among the rejected proposals.

A closer examination show that the approved proposals have significant higher scores on the attributes of research content, degree of innovation and general project quality than the rejected proposals. We also find that the approved proposals have a higher degree of technological risk that the rejected proposals.

Table 1 Correlation of private returns and spillovers evaluated in Provis for User-driven Innovation project proposals 2006-08.

		REJECTIONS (480 proposals)			APPROVALS (585 proposals)		
A6 Spillovers	Score 6 - 7		4 %	3 %		14 %	12 %
	Score 4 - 5	10 %	50 %	3 %	6 %	50 %	11 %
	Score 1 - 3	16 %	14 %		2 %	5 %	
		Score 1 - 3	Score 4 - 5	Score 6 - 7	Score 1 - 3	Score 4 - 5	Score 6 - 7
		A5 Private returns			A5 Private returns		

Preliminary analyses of the correlation between high scores in Provis and long-term effects indicate, so far, that research content has the largest impact on long-term success. The analyses of the correlation between attributes in the selection tool Provis and indicators of long-term success are at focus for work in progress.