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Evaluation of SkatteFUNN

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Preface

This is the first draft of the evaluation of SkatteFUNN.

The evaluation has been completed in accordance with the European Commission's guidelines by economists at Samfunnsøkonomisk analyse. The evaluation presents SkatteFUNN's impact on R&D expenditure, innovation and labour productivity. Furthermore, the evaluation compares the benefits of SkatteFUNN, in its positive additionality, and the costs of the scheme, through distortive effects and misuse.

As Project manager, I would like to acknowledge the substantial effort by Marina Rybalka, Marthe Norberg-Schulz, Rolf Røtnes, Fernanda Winger Eggen and Emil Cappelen Bjøru, Anders Håkansson and Tomas Åström. In addition, I would acknowledge the supervision, comments and discussions with both Michael Spjelkavik Mark, Roger Bjørnstad and Christian Hambro, Karen Helene Ulltveit-Moe and Pierre Mohnen which has contributed significantly to the evaluation.

Oslo, 10 November 2017

Andreas Benedictow
Project manager
Samfunnsøkonomisk analyse AS

Summary

This report evaluates the Norwegian tax credit scheme, SkatteFUNN. SkatteFUNN has been notified to European Surveillance Authority (ESA) as a research and development (R&D) scheme in accordance with EU's group exemption. The scheme has been preapproved by ESA. The preapproval implies that the Norwegian authorities conduct an impact evaluation in line with the European Commission Staff Working Document, *Common methodology for State aid evaluations*.

The Ministry of Finance has commissioned Samfunnsøkonomisk analyse AS and Technopolis Group represented by Faugert & Co Utvärdering AB to conduct the evaluation of SkatteFUNN.

In line with the EU's guidelines, the evaluation has tested and analysed whether SkatteFUNN 1) is aimed at a well-defined objective of common interest, 2) is designed to deliver the objective of common interest and 3) has a limited impact on the distortions of competition and trade.

1) Is SkatteFUNN aimed at a well-defined objective of common interest?

There is a general belief that investments in R&D is a key factor driving innovation and economic growth. A government can control the investments in R&D in the public sector, but can only stimulate the private sector to invest in R&D. Governments worldwide have therefore adopted various financial support instruments to promote R&D in the business sector. R&D tax incentives are among the most popular R&D policy tools.

The R&D tax incentive scheme SkatteFUNN was introduced in 2002, with the objective of increasing R&D investments in the Norwegian business sector and through this enhance innovation, as new production processes, products and services. The rationale is that firms overall will not invest a socially optimal amount in R&D, as positive external effects to other firms and the overall society are not fully internalised by the individual firms. Such positive external effects include dissemination of knowledge, new products and production opportunities, which may increase productivity growth and total income in the society as a whole. Furthermore, free riding could be a reason for underinvestment in R&D, as a firm may be likely to benefit from other firms' investments in R&D, which causes a disincentive to be the "first mover". In addition, it is often difficult to obtain funding for R&D projects in the private market, especially for small and medium sized enterprises (SME). The information possessed by the enterprise and the investor is typically highly asymmetric, causing higher risk.

The Official Norwegian Report (NOU 2000:7) laying the foundation for SkatteFUNN pointed out that it was necessary to also stimulate small R&D projects, typically for SMEs, to increase R&D in the business sector. At the time SMEs made little use of established R&D funding schemes.

SkatteFUNN decrease firms' cost of R&D investments up to set caps. SMEs may receive a tax credit of up to 20 per cent of the eligible costs related to R&D activity for approved projects, whereas large firms may receive a tax credit of up to 18 percent. If the tax credit for R&D expenses is greater than the amount that a firm is liable to pay in tax, the remainder is received from the Tax Administration through tax settlement. The scheme is widely utilised, and has become the largest public support scheme for private R&D investments in Norway. We argue that SkatteFUNN addresses a well-defined objective of common interest.

2) Is SkatteFUNN designed to deliver the objective of common interest?

The questions to answer here are a) does SkatteFUNN satisfy its operational target of higher R&D investments in the business sector and in SMEs in particular, b) do such investments fulfil the "real ambition" of more innovations and higher productivity, c) is SkatteFUNN appropriate and correctly proportioned to achieve these targets and d) what is the extent of misuse of the scheme?

a) SkatteFUNN significantly increases recipients' investments in R&D

Testing of additionality is crucial to documenting whether public support contributes to increasing investments in R&D, meaning that the aid is not a mere redistribution from taxpayers to some firms. We applied two different approaches to estimate additional investments due to SkatteFUNN, i.e. *input additionality*.

The first approach finds that only firms with R&D expenditures below the cost cap increase their R&D efforts. The second approach study how different changes in the scheme's cost caps have affected firms' R&D behaviour. This approach showed that overall, SkatteFUNN have high input additionality. For every NOK 1 of tax credit we estimate that R&D expenditures increase by more than NOK 2. The effects vary a lot depending on the type of change in the scheme and when the firms received SkatteFUNN for the first time (grouped into different generations of users).

Overall, the input additionality is reduced over time. This is because new generations of SkatteFUNN users have lower additionality, while the earlier generations tend to keep their higher additionality over time. Our interpretation is that the most competent firms also are the most efficient to sign up for SkatteFUNN. It follows that the pool of highly efficient firms was (almost) emptied at the introduction of the scheme, and therefore accounts for an ever-smaller proportion of the following generations. The increased cost cap in 2009 does not seem to have any additional effect, but this must be seen in the context of the financial crisis when extra support was needed just to keep R&D investments going. The expansions done in 2014 and 2015 are found to have had a positive additional effect, especially on the earliest generations of SkatteFUNN users. Our estimates of input additionality are in line with the previous study of SkatteFUNN, which is somewhat higher than what is typically found in international studies of comparable schemes.

b) SkatteFUNN enhance innovation and productivity

We analyse the effects of R&D investments on several result indicators, specifically the effect of R&D investments on innovations, labour productivity and external effects of R&D investments. This is referred to as output additionality. Although it seems to be broadly agreed upon that R&D tax incentives result in increased R&D expenditure due to a reduction in the marginal cost of R&D investments, studies documenting the effectiveness of R&D tax incentives on innovation are rare.

We find that R&D investments in general, and over time, increase labour productivity. Moreover, our results show that SkatteFUNN projects have the same effect on labour productivity as other R&D projects.

The external effects of R&D are difficult to measure quantitively. We apply a “distance to R&D” approach to identify spillovers, though the results of this econometric analysis are inconclusive. In our survey Skatte-FUNN users report that projects have benefited the firms’ customers in terms of better products or services. Moreover, a majority of respondents answered that strengthened competitiveness and dissemination of competence through staff mobility and cooperation were results of the SkatteFUNN project(s).

c) Appropriateness and proportionality

Norway has several schemes supporting R&D in the business sector. SkatteFUNN is specially directed to support SMEs R&D projects. Our assessment is that SkatteFUNN is more suited to this task than other similar schemes. Around half of the users are firms with less than 10 employees. This is a significantly larger share relative to other direct R&D support schemes, e.g. the Research Council of Norway’s (RCN) User-driven Research based Innovation programme (BIA).

SkatteFUNN was proposed and implemented as a neutral scheme giving firms with R&D projects the right to tax deductions of up to 20 percent on the costs associated with R&D projects. A major advantage of SkatteFUNN, compared to many other national schemes, is its neutrality along most dimensions, as geographic location, industry, ownership, result and subject of R&D. Being a rights-based scheme, decisions on R&D investments are left to the market. That SkatteFUNN is available to all, without a time consuming and costly application process for the authorities as well as firms, is also a main difference from other R&D enhancing schemes, where firms need to apply for subsidies or participate in projects and networks. The process involving application for R&D schemes is often a barrier for SMEs with little or no experience with these processes. Other studies show that input additionality for SkatteFUNN is higher than for other support schemes for R&D.

As part of the evaluation we have investigated how SkatteFUNN performs relative to IN and RCN in terms of various indicators regarding the outcome of the R&D activity. We find that the most frequently reported outcome is development of entirely new technical solutions, followed by testing and implementation of technical solutions new to the firm. This indicates that SkatteFUNN projects are first and foremost development projects directed towards improvement of the firms’ products or services. We also find that SkatteFUNN projects have the same possibility to be new to the market as R&D projects supported by RCN in general, and a higher possibility than for projects supported by Innovation Norway (IN).

Regarding proportionality, we must consider that additionally is decreasing with size of the project and that few users reach the project cost cap. Our assessment is that the cost cap now has been raised to such a high level that the cap is no longer relevant for SMEs. An increase will only benefit the largest firms, which is not in line with the schemes objective. We also consider the difference between the rates of 20 and18 percent for SMEs and large firms as very small, and would suggest to either differentiate properly, for instance by rising the rate to 25 per cent for SMEs, or offer one rate for all in order to simplify the scheme further. The cap on wage rates was introduced in 2006 to address potential misuse, but exactly where to put the cap is not obvious. We have no clear opinion on whether the level should be changed, but suggest regular inflation adjustments rather than the seemingly arbitrary adjustments.

d) Misuse is likely limited

The extent of misuse of SkatteFUNN is analysed on the basis of indicators selected in collaboration with the Norwegian Tax Administration. We have found examples of what can be interpreted as tax motivated misuse of the scheme. The analysis does not provide any indications of extensive misuse, although it is impossible to quantify at this point due to lack of data.[1] To some extent, however, one must accept misuse as a cost to support schemes intending to attract many firms. This is particularly so when, as is the case with SkatteFUNN, control routines and administrative expenditures are kept at a low level.

3) Does SkatteFUNN limit the distortions of competition and trade

We have assessed potential distortive effects of SkatteFUNN on competition and trade. These may be positive, as well as negative. First of all, SkatteFUNN is neutral by design. Being a rights-based scheme, there is no selection bias related to receiving SkatteFUNN. Neutrality is achieved along most other domestic dimensions, including location, industry, ownership, result, and subject of research. We do find evidence of a slight favouring of SMEs, as intended, which arguably has a positive impact on competition as it reduces the entry barriers and counteracts the bias towards large firms by other available R&D schemes. We do not find any evidence that firms receiving SkatteFUNN have any negative impact on non-beneficiaries.

Internationally, we find that a relatively small share of the exporting recipients receives aid above the threshold of de minimis aid. It is also important to note that even if support exceeds this threshold, it need not be distortive. Furthermore, users of SkatteFUNN are found to import more from foreign firms, which is a positive externality for Norway's trading partners.

To the extent that there are distortive effects of SkatteFUNN they are probably applicable also to most of the other member states having similar arrangements, levelling out the distortions. Overall, we argue that the positive distortive effects probably outweigh the negative.

Concluding remark and central policy implications

We conclude that the benefits from SkatteFUNN of positive additionality and net positive effects of competition and trade exceed the costs of negative distortive effects and misuse. This leads us to a clear recommendation of continuing the SkatteFUNN scheme. However, the project cost cap is now raised to such a high level that further increases will only affect large firms. This points to not expanding the project cost cap further. We also find indications that additionality is decreasing over time. To stimulate R&D in SMEs further through SkatteFUNN, there are two relevant options, 1) increasing the tax credit rate for SMEs above todays' 20 per cent or 2) increasing the cap on hourly wage. If the authorities wish to stimulate R&D on a general basis, they may as well consider alternative measures, i.e. through RCN or IN.

[1] We are expecting data from the Tax administration during the spring, hopefully in due time for the final report.

Contents

1 Introduction

SkatteFUNN is a research and development (R&D) tax incentive scheme introduced in 2002. The scheme aimed at stimulating R&D in the business sector. The rationale for initiating SkatteFUNN was the need to enhance research and development in the Norwegian business sector.

NOU 2000: 7, the green paper that laid the foundation for SkatteFUNN, pointed out that in order to increase R&D in the business sector, there was necessary to stimulate R&D in small and medium sized firms which at the time made little use of established R&D funding schemes.[2]

SkatteFUNN is set to incentivise the private sector to conduct R&D by decreasing the realised cost of R&D investments. Small and medium sized firms may receive a tax credit of up to 20 per cent of the eligible costs related to R&D activity for approved projects, whereas large firms may receive a tax credit of up to 18 percent of eligible costs. All costs must be associated with the approved project. To qualify as R&D, any activity must meet the definitions set out by the Research Council of Norway. If the tax credit for the R&D expenses is greater than the amount that the firm is liable to pay in tax, the remainder is paid in cash to the firm. If the firm is not liable for tax, the entire allowance is paid in cash.

The Ministry of Finance has commissioned Samfunnsøkonomisk analyse and Technopolis Group represented by the Swedish subsidiary Faugert & Co Utvärdering AB to conduct an evaluation of the Norwegian R&D tax deduction scheme called SkatteFUNN.

1.1 Evaluating SkatteFUNN

The evaluation shall be carried out according to the Guidelines on State Aid. The most recently updated methodology for state aid evaluations is outlined in the Commission Staff Working, *Common methodology for State aid evaluations* (European Commission, 2014). This document outlines the necessity for following a comprehensive plan in an evaluation of a state aid scheme.

The assessment of an aid is fundamentally about balancing its negative effects on trade and competition in the common market with its positive effects in terms of a contribution to the achievement of well-defined objectives of common interest.

For that purpose, the Commission has established a test which consists of the following questions[3]:

1. Is the aid measure aimed at a well-defined objective of common interest?
2. Is the aid well designed to deliver the objective of common?
3. Are the distortions of competition and effect on trade limited?

The first two questions address the positive effects of a State aid measure, whereas the third question refers to its negative effects on competition and trade and compares the positive and negative effects of the aid.

1.1.1 Contribution to a common objective

To contribute to a common objective, the scheme must address a market failure.

The underlying argument for the scheme is that the level of R&D investments would be below the socially optimal level in absence of the scheme. This

[2] The scheme was introduced as a follow-up of the Official Norwegian Report (green paper), NOU 2000: 7 "Ny giv for forskning".

[3] See Common principles for an economic assessment of the compatibility of State aid under Article 87.3.

is based on the existence of positive externalities of R&D investments that are not fully appreciated by the deciding agents.[4]

Furthermore, there may be information asymmetries causing market failure in funding R&D investment. For instance, firms have better market knowledge and product understanding than banks and investors, leading to credit or liquidity constraints. This is especially an issue for small and medium sized enterprises (SMEs).

The purpose of SkatteFUNN is to enhance R&D investments in the business sector through a tax incentive that stimulates investments in research and development (R&D). The tax incentive is assumed to be relatively more important for SMEs than to large ones.

In this evaluation we will assess whether SkatteFUNN has the intended effects, i.e. does it lead to more R&D investment in the business sector and to innovations, especially for SMEs. This assessment includes evaluation of both direct and indirect effects. The direct effect includes the impact on the course of action taken by the aid beneficiaries, the impact on additional R&D investments and whether private investments match the forgone tax revenues.

By indirect effects, we mean the effect on variables not directly targeted by the policy. Positive spillover effects, because of the scheme, may enhance potential positive direct effects. Among the possible positive effects, macroeconomic gains and positive externalities are perhaps the most important. Result indicators for the former, specified in the European Commission's working document, are employment and productivity.

Productivity is a gain for both the firms itself and the economy as a whole, because it implies a more efficient usage of scarce resources. It entails an aggregated competitive gain for the economy, as productivity is an indicator of an economy's competitiveness. Because the existence of spillover effects is the main market failure that SkatteFUNN attempts to correct, the evaluation could pay specific attention to this matter. Increased cooperation between beneficiaries and approved research institutions could also cause spillover effects, as the information sharing this implies likely eventuate in a wider dispersal of the gains from R&D.

1.1.2 Is SkatteFUNN well designed to deliver the objective of common interest?

In most countries, there is a variety of instruments in place to stimulate increased R&D. The government produces R&D on its own, through universities and publicly backed research institutions, and enforces intellectual property rights and the rule of law.

Furthermore, governmental competition authorities ensure that market power is not concentrated in a way that could reduce the incentive to invest in R&D. In addition, governments are actively promoting well-functioning capital markets.

The evaluation assesses whether SkatteFUNN is an appropriate policy instrument to address the objective. This assessment includes answering what the cost of SkatteFUNN is compared to the estimated impact? A crucial question in this regard is whether less aid or a different form of aid could attain the same impact. Could for example direct

[4] Externalities refers to situations when the effect of production or consumption of goods and services imposes costs or benefits on others which are not reflected in the prices charged for the goods and services being provided.

grants be more efficient in stimulating R&D investments? A direct subsidy scheme would differ from SkatteFUNN, because the aid would require a more comprehensive process of approval, whereas SkatteFUNN is rights based.

Evaluating whether other instruments can result in the same achievement is not included in the mandate of this evaluation. However, we have assessed the impact of alternative instrument by reviewing evaluations done by others.

We will also debate whether the positive impact of SkatteFUNN can be hampered by misuse, and how compliance can be ensured.

1.1.3 Does SkatteFUNN cause an unacceptable degree of distortion on competition and trade?

One specific negative side effect mentioned in the European Commission's working document is the potential impact on competition and trade. The evaluation should therefore also attempt to measure aggregated effects on competition and trade.

To analyse the impact on competition and trade, we have identified when such effects may occur. This is done by identifying whether SkatteFUNN has a distortive impact on domestic competition and whether beneficiaries are active in export markets, and to what extent.

1.2 Disposition

Chapter 2 discusses the common objective of the scheme and its historical background, in addition to descriptive statistics of the beneficiaries of SkatteFUNN.

Chapter 3 provides an overview of international R&D tax incentives, including a summary of international evaluations of schemes.

In Chapter 4, we present our estimated input additionality of SkatteFUNN. The estimated output additionality is presented in Chapter 5.

In chapter 6, we analyse the outcome of SkatteFUNN projects, including innovations and patents.

Chapter 7 presents the administrative costs of SkatteFUNN, including how beneficiaries view the application and reporting process.

In chapter 8, we discuss the potential of misusing the scheme, including indicators of misuse. We also put forward our recommendations for reducing the scope of misuse.

Chapter 9 deals with SkatteFUNN potential distortive effects on competition and trade. We conclude that the distortive effect of the scheme is not significant.

Finally, in Chapter 10, we summarise our findings by balancing the benefit of SkatteFUNN, i.e. the value-added effects from increased R&D investments, and the social cost of the public contribution (cost of taxation), the net effects on trade and competition and misuse of the scheme.

2 The Norwegian tax credit scheme for R&D

SkatteFUNN is a tax deduction scheme established in 2002 with the objective to stimulate R&D investment in Norwegian firms, especially small and medium sized. Around half of the recipients are firms with less than 10 employees (however, this has decreased over time). This is a significantly larger share relative to comparable schemes (e.g. the RCN's BIA). SkatteFUNN was proposed and implemented as a neutral scheme giving firms with R&D projects the right to tax deduction of up to 20 percent on the costs associated with R&D projects. Firms belonging to three industries stand out as the most intensive users of the scheme; advanced manufacturing, ICT and professional, scientific and technical activities. The two latter have increased their share of total users throughout the period 2002-2015. New users of SkatteFUNN make up approximately 20 percent of the recipients of SkatteFUNN each year. Thus, the main share of firms receiving an R&D tax credit are "regulars" and their age has naturally increased over time. Of the SkatteFUNN users, 41 percent have not received support from any other business support scheme. Measured in number of SkatteFUNN recipients receiving support from other schemes with similar objectives as SkatteFUNN, Innovation Norway's "industrial R&D contracts" is the most used. Of the ten most used other support schemes seven are R&D programs in the Research Council.

This chapter describes the motivation for SkatteFUNN, its history, how the scheme works, the amount of public support, the scheme's target group and characteristics of the users.

2.1 Why public support of private R&D?

Research and innovation lead to new ideas, and translate in to new and better products and improved productivity. Eventually this increases general welfare.

However, markets left on their own will probably generate less innovation than would be desirable from society's point of view. This could be due to risk aversion and the fact that knowledge is not completely excludable. R&D investments is subject to the classical free rider problem of public goods.[5] R&D investments are characterized by high risk and having high start-up costs, but relatively low marginal costs. Typically, these investments also face a low probability of success, but provide significant proceeds if succeeding.

When a firm succeeds in developing ideas, these can be easily copied and utilised by other firms. Non-excludability discourages firms to invest in research since the returns to investment will not entirely accrue to the firm. It is therefore well-recognized in economic literature that the broader economic effect of R&D investments exceeds the private economic effects (Arrow, 1962).

Furthermore, it is often difficult for firms to obtain funding for innovation projects in the private market. The information possessed by the firm and the investor is typically highly asymmetric, causing higher risk.

Because of the various positive externalities following investments in R&D, these investments conducted by the business sector will be less than what is socially optimal (NOU 2000: 7).

[5] A public good is characterized as being non-rivalrous and non-excludable. Meaning that the usage by one entity does not precludes the usage by another entity, and that it is not possible to prevent others from utilizing the invention. In fact, some public goods, such as knowledge, will accumulates if everyone uses it. *"If you have an apple and I have an apple and we exchange apples then you and I will still each have one apple. But if you have an idea and I have an idea and we exchange these ideas, then each of us will have two ideas" – George Bernhard Shaw.*

To incentivise R&D in the private sector, public support is a solution. All OECD countries are currently spending significant amounts of public money on schemes intended to stimulate R&D activity. One example is the EU's framework programme for Research and Innovation (Horizon 2020) allocating a staggering € 70 billion for supporting R&D (and innovation) in years 2014-2020.

2.2 Implementing SkatteFUNN

The Hervik committee originally proposed the SkatteFUNN scheme in 2000, cf. NOU 2000: 7. The primary objective of the committee was to evaluate and suggest appropriate measures to stimulate private investment in R&D.

The Hervik committee recommended additional governmental intervention to increase R&D activities in Norway. This argument was based on the various forms of market failures impeding the market's ability to reach the socially optimal level of R&D (NOU 2000: 7). The objective was to enhance R&D in the private sector, especially among small and medium sized enterprises (SME). The committee referred to studies and data that substantiate that SMEs typically find investments in R&D too risky and resource intensive, and have historically not been able to prioritize R&D investments without external incentives. The implementation of SkatteFUNN provided such an incentive.[6]

Furthermore, the Hervik committee underlined explicitly that SkatteFUNN should complement direct funding schemes. In this way the committee implicitly assumed that existing direct R&D supporting schemes did not reach SMEs sufficiently.

SkatteFUNN was implemented in 2002 as a tax deduction scheme.[7] The objective is to stimulate investment in research and development (R&D) in the Norwegian business sector, cf. Innst. S. nr. 325 (2001) and Ot. prp. nr. 1 (2002). The scheme is rights based, and provide all taxable firms in Norway with the opportunity to apply for tax deduction on their costs related to R&D projects. Firms that are not tax liable have the option of receiving the amount in cash grants.

A consequence of SkatteFUNN is a reduction in the cost of R&D investments. Thus, the scheme is expected to initiate R&D projects that otherwise would not have been initiated or increase investments in already initiated R&D projects. We test whether this is the case in chapter 4. Here it is worth mentioning that the relationship between firms' expected risk and subsequent cost of R&D determines how many R&D projects will be carried out. The cost of an investment plays a significant role of perceived risk. The higher the cost, the greater the risk.

The above argument is purely theoretical and based on several assumptions, including that the firm is purely rational, that is has full information on both costs and return of the investment, and that the firms has the resources (human, technical or financial) available to conduct R&D investments. This will not always be the case, maybe even never. Especially for SMEs and firms without experience in research, these assumptions may not be met. This will lead to higher perceived risk, which in turn will lead to higher capital costs, see Hall and Lerner (2010). This may indicate that lowering the costs of R&D investments will have a greater effect on SMEs and firms with little or no R&D experience.

[6] Click here to view an article about the evaluation in 2008

[7] Exclusive taxation provisions for costs associated with R&D did not exist in Norway prior to 2002.

2.3 Eligible recipients

SkatteFUNN is neutral along most dimensions. SkatteFUNN applies to all firm sizes, all industries and all types of business entities, irrespective of geographic location. Firms can themselves decide which projects to invest in. The R&D projects promoted by SkatteFUNN can be within all disciplines, but must have the objective of creating new knowledge or new experiences in association with development or improvement of goods, services or processes.

It is also an objective for SkatteFUNN to provide support to small, and possibly not yet profitable entities. Firms that are not in a taxable position will receive the amount as cash grants. This feature is not present in many other, otherwise comparable, national schemes.

However, the scheme differentiates somewhat between SMEs and large firms. Large firms have the opportunity, through SkatteFUNN, to receive a tax deduction of up to 18 percent on costs associated with R&D projects, whereas SME is entitled to a tax deduction of up to 20 percent on their costs.

The tax deduction basis can be divided in two parts; one deals with the costs related to intramural R&D projects, whereas the other part is tied to the costs related to externally purchased R&D services. The externally purchased services are conducted by the Research Council of Norway's (RCN) approved research institutions, and contributes to stimulating the disseminations of knowledge and ideas though enhancing collaboration between public and private organisations.

2.4 Approval process

SkatteFUNN projects begins with project planning and an application for approval for tax deduction to the RCN. When the firm receives the approval, typically covering a period of three years, and the project is up and running, the firm simply provides an annual report to the RCN. A final report shall be sent to the RCN when the project is completed.

The firm is obliged to have separate project accounts that show how many hours each employee has worked on the project, which part of the project the employee worked on and their hourly cost. These accounts are to be kept on a continuous basis. Claims for tax deductions are forwarded with the annual tax return, and only the costs incurred during the tax year can be included. The claim is only sent to the tax authorities.[8]

RCN's task is to determine, ex-ante, whether the project can be considered R&D in terms of the law. The project shall be limited and aimed at acquiring new knowledge, information or experience that is believed to be of benefit when developing new or better products, services or methods of production. Ordinary product development, without the research touch, does not provide the firm with tax deduction rights through SkatteFUNN. If RCN identify activities that are not considered R&D, such as marketing of a new product, the application will either be rejected, or the approval will exclude the marketing activities. Auditors and the tax authorities must determine whether the costs stated by the firm are correct and sufficiently documented. The tax authorities also decide if any grants or income from the project are to be deducted from the eligible project costs.

[8] The claim is sent through an attachment called RF-1053

2.5 Changes since implementing SkatteFUNN

Since SkatteFUNN was implemented in 2002 there has been several changes of the scheme, cf. Figure 2.1.

Firstly, in 2007, there was implemented a cap on the hourly wage and yearly hours spent. The maximum hourly rate was limited to NOK 500 and the maximum number of hours was 1 850. In 2011, the maximum wage rate was increased to 530. Then in 2014, it was increased to NOK 600.

Secondly, SkatteFUNN has been expanded in five rounds; 2009, 2014, 2015, 2016 and 2017. Each extension expanded the tax deduction base with the objective of further stimulating economically profitable R&D investments in private organisations.

The first extension, in 2009, was implemented by the Stoltenberg II-administration as one of several tools intended to dampen the effect of the Global Financial Crisis, cf. St.prp. nr.37. The extension meant an increase in the tax deduction base on internally completed R&D projects, from 4 to 5.5 million, and an expansion of the maximum sum of externally purchased R&D, from 8 to 11 million. The 2009 extension was recommended in the 2008-evaluation of SkatteFUNN by Statistics Norway (Cappelen et al., 2008).

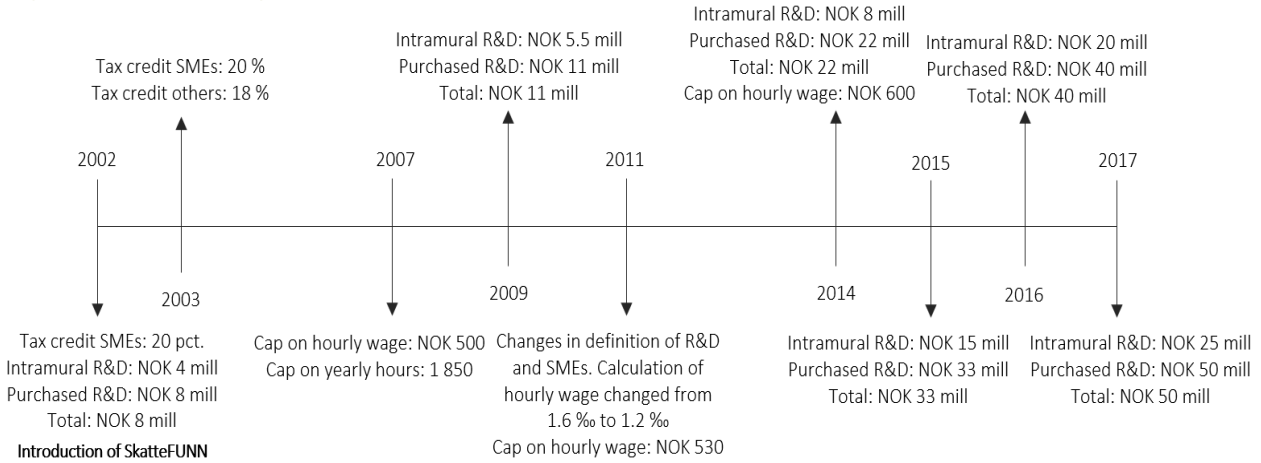
In 2014, there was a further increase in the tax deduction base on internally completed R&D projects, this time from 5.5 to 8 million. The maximum sum for both internally completed and externally purchased R&D increased from 11 to 22 million.

Since 2014, there has been three consecutive changes in the scheme. In 2015, the threshold for costs related to internal R&D projects increased from 8 to 15 million, and an increase in the maximum sum of internally completed and externally purchased from 22 to 33 million.

Then, in 2016, there was implemented a further increase from 15 to 20 million for internal projects and from 22 to 40 million in externally purchased R&D.

Today, the thresholds amount to 25 and 50 million respectively.

Figure 2.1 Main changes in the scheme



Source: The Ministry of Finance

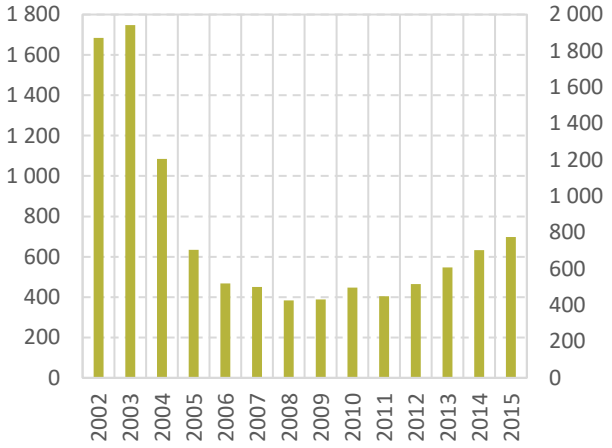
These latest extensions are intended to further facilitate larger R&D projects, and thereby strengthen R&D in the business sector. In addition to stimulate larger R&D projects, the extension may also facilitate a more rapid completion of the projects.

Ex-ante and ex-post adjustment assessments provide valuable information about SkatteFUNN's impact. The adjustments are therefore central to the impact evaluation, see chapter 4 and 5.

2.6 Usage of and forgone revenue due to SkatteFUNN

There has been a marked increase in the number of SkatteFUNN projects in recent years. Further, it has been an increase in the number of new firms utilizing the scheme in the period after 2009.[9] However, compared to the first couple of years after the introduction of the scheme, the annual number of new firms is relatively low.

Figure 2.2 Number of new SkatteFUNN firms.

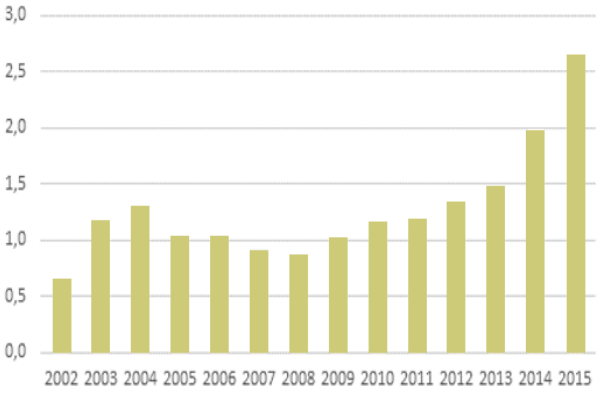


Source: Statistics Norway and Samfunnsøkonomisk analyse

We are aware that the increase in the total number of SkatteFUNN projects (or at least applications) is partly because the Research Council has taken it upon themselves to mobilise firms to apply for SkatteFUNN. Thus, the increase may not necessarily be seen as an increase in firms' R&D activity but merely an increase in R&D active firms applying for an R&D tax credit.

Figure 2.3 illustrates the development of forgone tax revenue due to SkatteFUNN. The amount has been increasing significantly over the past few years, especially with the increases in the cost caps. The forgone tax revenue is estimated at about NOK 3,5 billion for 2016.

Figure 2.3 Forgone tax revenue in NOK billion.



Source: Tax administration

2.7 Characteristics of users of SkatteFUNN

In this chapter we will provide an empirical description of the users of SkatteFUNN. As described above, there has been made several changes in the scheme since the introduction in 2002. In the following we present what characterise users of the scheme and whether this has changed with the changes in the scheme. To do this we have divided

[9] The previous evaluation (and our data) showed that there are several R&D performers (firms) that do not apply for an R&D tax credit. Thus, the increase in number of applicants does not necessary imply an increase in R&D activity.

the data in six regimes; 2002-2003, 2004-2006, 2007-2008, 2009-2010, 2011-2013 and 2014-2015.

The description will be based on data from the SkatteFUNN project database and a survey of 600 randomly selected beneficiaries of SkatteFUNN.[10]

2.7.1 Industrial distribution

Independent of regime, measured in number of recipients of an R&D tax credit, three industries stand out; advanced manufacturing, ICT and professional, scientific and technical activities. The two latter have mainly increased as share of total recipients throughout the period 2002-2015 (cf. Figure 2.4). With the increase in these industries, the share of manufacturing firms has decreased.

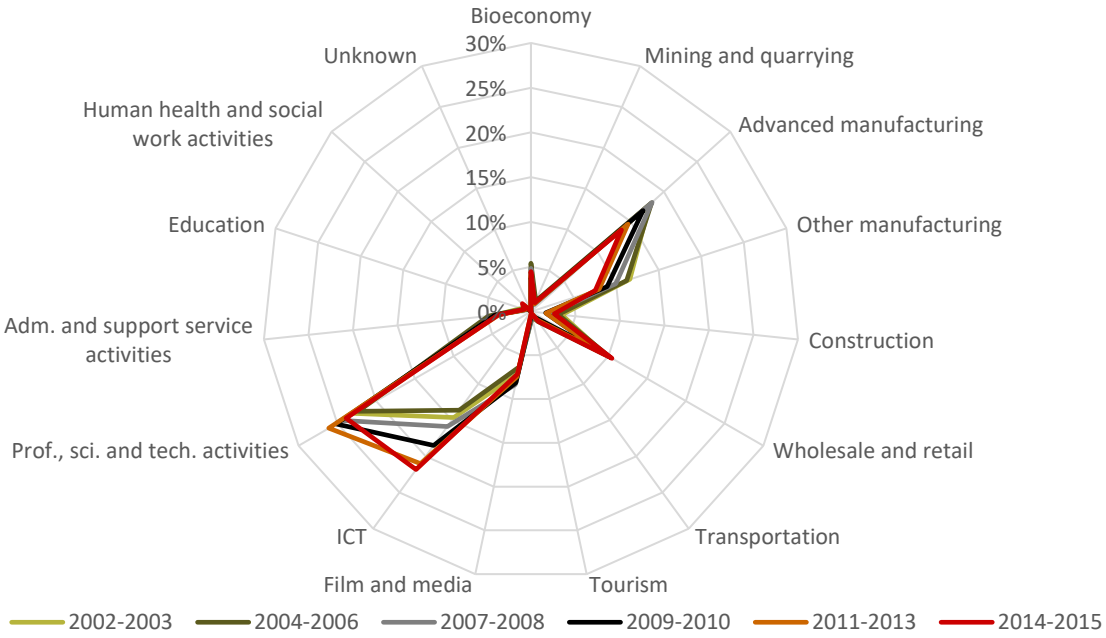
Looking closer at which industries within ICT and professional, scientific and technical activities firms with R&D tax credits belong to, we see that it is computer programming and engineering activities that make up the largest share of all recipients (cf. Figure 2.5).

Within advanced manufacturing, most firms receiving an R&D tax credit are manufacturers of machinery and equipment, fabricated metal products and electronic and optical products (cf. Figure 2.6).

Compared to the industrial distribution among recipients of other selected schemes, firms receiving R&D tax credits are more equal to firms receiving support from schemes with similar objectives from Innovation Norway, than firms receiving R&D grants from the RCN. SkatteFUNN and Innovation Norway both have a relatively high share of recipients within ICT, whereas the RCN have a higher share of recipients within professional, scientific and technical activities (Cappelen et al., 2016).

[Note: We will make an updated industrial comparison for different schemes to the final draft]

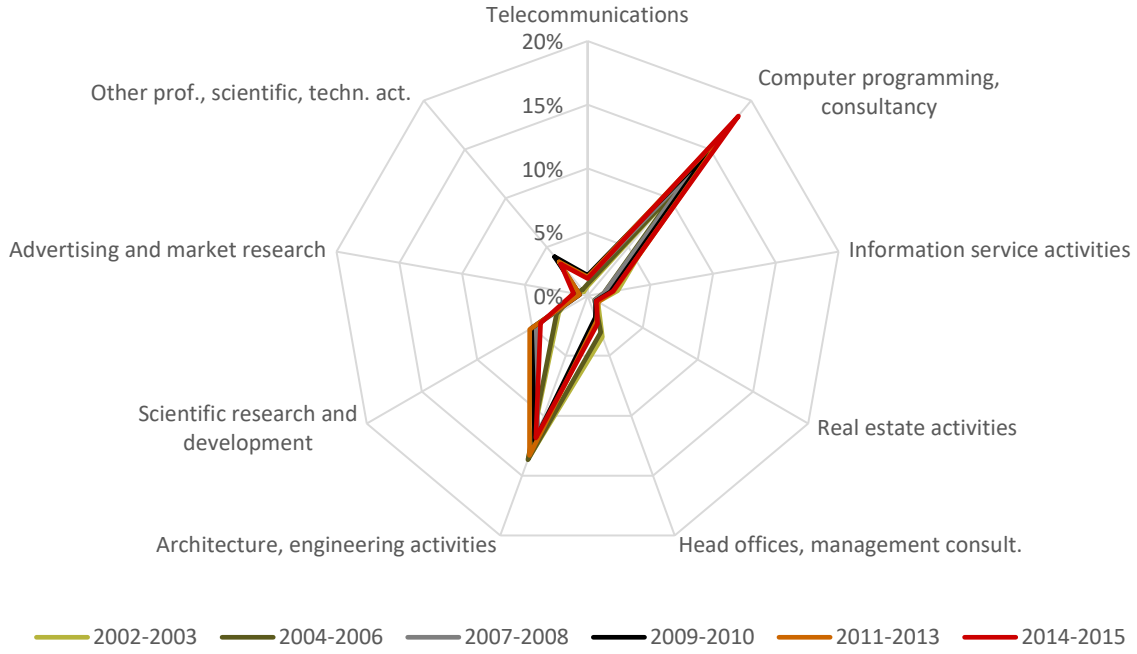
Figure 2.4 SkatteFUNN recipients by industry. Share of total. 2002-2015



Sources: Statistics Norway and Samfunnsøkonomisk analyse

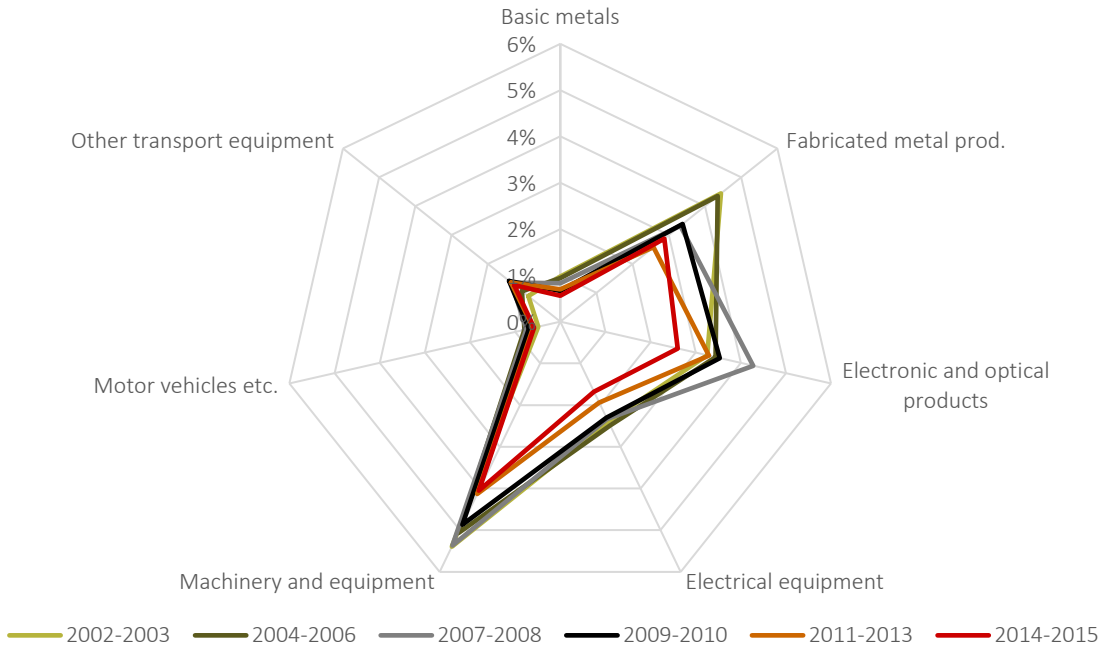
[10] For more details about the survey see Appendix A.

Figure 2.5 SkatteFUNN recipients by industry. ICT, professional, scientific and technical activities. Share of total. 2002-2015



Sources: Statistics Norway and Samfunnsøkonomisk analyse

Figure 2.6 SkatteFUNN recipients by industry. Advanced manufacturing. Share of total. 2002-2015



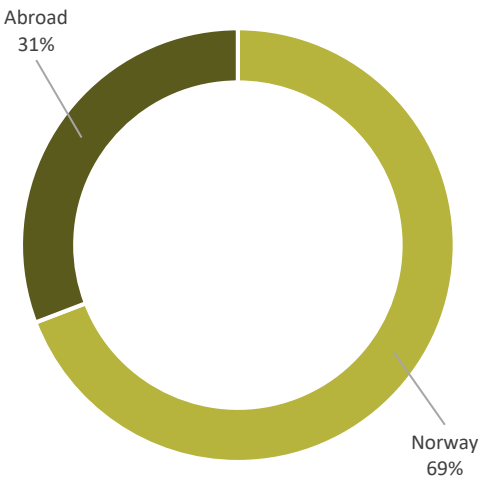
Sources: Statistics Norway and Samfunnsøkonomisk analyse

2.7.2 Origin of customers of SkatteFUNN firms

Around two-thirds of the firms state that the majority of their customers are in Norway, while the remaining firms mainly identify themselves as exporters (i.e. having the majority of customers outside Norway), cf. Figure 2.7.

Micro-firms (fewer than 10 employees) are over-represented in the latter category. The share of export firms is also higher among firms that have had more than one SkatteFUNN project; among firms with six or more projects, 40 percent state that they are exporting firms. Note that all legal firm forms in the SkatteFUNN project database were included (i.e. none was eliminated).

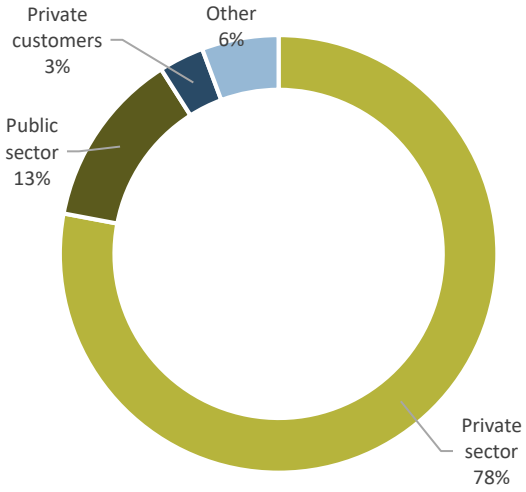
Figure 2.7 Origin of customers of SkatteFUNN firms. N=594.



Source: Technopolis web survey

Almost four out of five firms (78 percent) have most of their customers in the private sector, 13 percent in the public sector and 3 percent mainly have private customers; the remaining firms could not place their firm in either of the abovementioned categories, cf. Figure 2.8.

Figure 2.8 Origin of customers of SkatteFUNN firms. N=594.

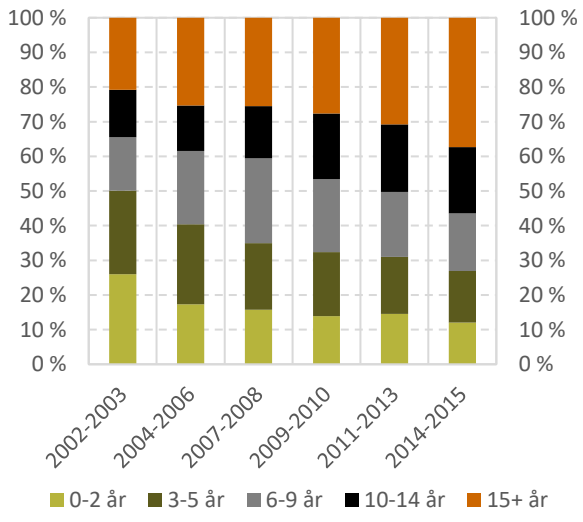


Source: Technopolis web survey

2.7.3 Firm age

With respect to firm age, firms receiving an R&D tax credit has become more mature for each change in the scheme (cf. figure 2.9Figure 2.9). There may be several reasons for this. Firstly, new users of SkatteFUNN make up approximately 20 percent of the recipients of SkatteFUNN each year. Thus, the main share of firms receiving an R&D tax credit are “regulars” and their age has naturally increased over time.

Figure 2.9 Firm age when receiving and R&D tax credit



Sources: Statistics Norway and Samfunnsøkonomisk analyse

Secondly, the share of more mature firms among new users of the scheme as increased over time (cf. Figure 2.10). This is in line with the purpose of the last three changes in the scheme; increasing the limit for tax-deductible R&D expenditure to motive larger firms to apply for an R&D tax credit. Larger firms are normally more mature firms.

Figure 2.10
Firm age first year with an R&D tax credit. 2002-2015

Sources: Statistics Norway and Samfunnsøkonomisk analyse

2.7.4 Firms size

Around half of the recipients of R&D tax credits are firms with less than 10 employees. However, the share of firms with less than 10 employees has decreased over time among those who continuously use SkatteFUNN (cf. Figure 2.11). This is reasonable, given that the main share of recipients are firms that continues to use the scheme; both firm age and size increases.

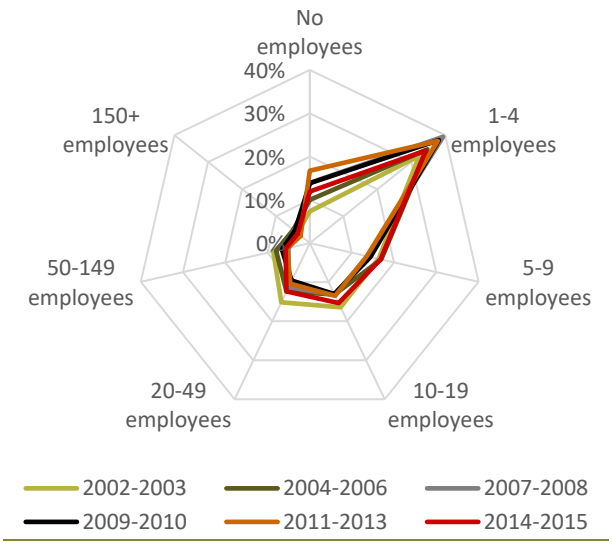
Among new applicants the share of firms with less than 10 employees have been relatively stable over time. Further, more than 80 percent of new applicants, as well as the "regulars", are firms with less than 50 employees.

The annual R&D surveys conducted by Statistics Norway are sent to all firms with more than 50 employees, but only to a selection of firms with 10-50 employees. Thus, a significant share of recipients of SkatteFUNN are not included in statistics on firm's R&D expenditures. Challenges related to this is commented in more detail in Chapter 4.

Figure 2.11
Firm size when receiving an R&D tax credit. 2002-2015

Sources: Statistics Norway and Samfunnsøkonomisk analyse

Figure 2.12
Firm size first year with an R&D tax credit. 2002-2015



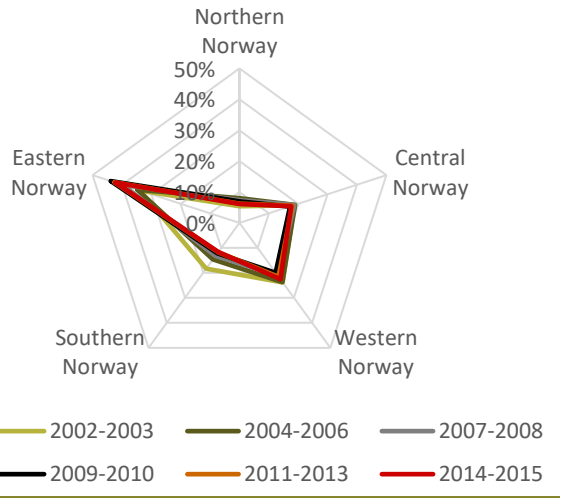
Sources: Statistics Norway and Samfunnsøkonomisk analyse

2.7.5 Geographical distribution

Almost half of all recipients are located in Eastern Norway. According to Cappelen et al. (2016) the geographical distribution of recipients of SkatteFUNN is almost identical to the distribution of firms receiving R&D grants from the Research Council of Norway, whereas firms with support from Innovation Norway's schemes with comparable objectives have a somewhat different geographical distribution.

Of the firms located in Eastern Norway, half are located in Oslo.

Figure 2.13 Firms by region.



Sources: Statistics Norway and Samfunnsøkonomisk analyse

2.7.6 Experience with R&D

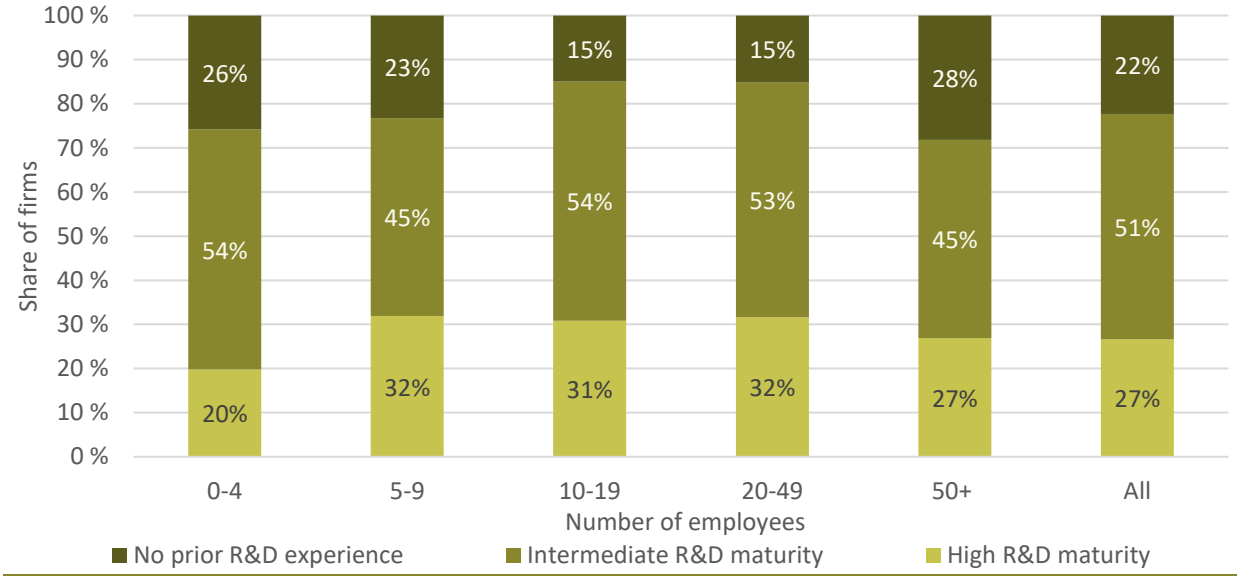
Firms were asked to self-assess their level of experience of research and development (R&D) prior to the start of their first SkatteFUNN project. For our further analyses, we have grouped firms in three levels of "R&D maturity". The first category contains firms that reported that they had no experience with R&D before commencing their first SkatteFUNN project, and includes 22 percent of firms. The category with intermediate R&D maturity comprises 51 percent of firms, and includes firms that responded that they had:

- experience of using openly available R&D results, or
- experience of buying R&D services from an external supplier, or
- experience of R&D performed in-house, or
- R&D as an integrated process for development of new products or services.

The third category of R&D maturity consist of firms which stated that "R&D was significant for the firm's business development and considered to create clear competitive and/or efficiency benefits", which we interpret as high R&D maturity; this category includes 27 percent of firms.

Figure 2.14 shows the R&D maturity of firms by firm size. Firms with 5–49 employees had the highest R&D maturity prior to their first project, and also included the lowest share of firms with no experience of R&D. The smallest and the largest firms (fewer than 5 or more than 49 employees) included the highest shares of firms with no experience of R&D prior to their first project. A slightly larger share of firms in manufacturing had a high degree of R&D maturity (31 percent), compared to firms in the other business sectors (27 percent). Firms with more experience of R&D are also more likely to have had multiple SkatteFUNN projects.

Figure 2.14 R&D maturity of firm before its first SkatteFUNN project. N=597.



Source: Technopolis web survey

2.8 SkatteFUNN among other R&D enhancing instruments

A first look at SkatteFUNN recipients' use of other schemes, indicate that the share of firms receiving support from Innovation Norway and the Research Council have increased over time. However, as we will discuss below, there are several possible explanations for this, which is not necessarily related to their use of SkatteFUNN.

To distinguish between the effect of SkatteFUNN and other schemes intended to have impact on firms R&D activity, it is interesting to know the extent of support from other (relevant) public funding schemes. In addition, the extent of support from other schemes can be considered as a result the scheme itself. That is, it is conceivable that SkatteFUNN projects increase firms' R&D maturity, which in turn may lead them to apply for public funding of larger and more complex research projects from funding agencies such as the RCN and/or various EU programs (e.g. Horizon 2020). This is sometimes referred to as climbing the "research stair".[11]

Earlier attempts to study firms' use of public funding scheme indicate that it is difficult to document firms' development in the so-called research stair. Further, given that all firms with an approved research project can apply for SkatteFUNN, they may receive

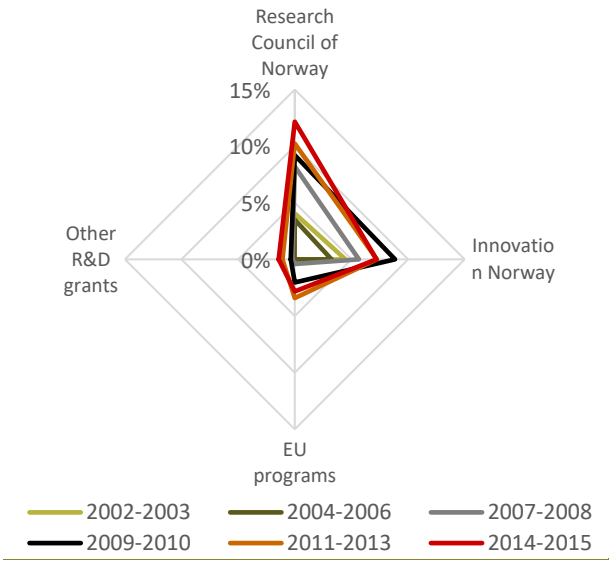
[11] Not necessarily a well-established expression, but is a good illustration of how to imagine firms develop in their use of public schemes.

an R&D tax credit every year while receiving support from other schemes "higher" in the stair.

In the following we document SkatteFUNN recipients' support from other public schemes. We are not able, within the scope of this evaluation, to determine the causal link between changes in the use of other schemes and SkatteFUNN. The analysis below should therefore be read as a clarification of what characterises SkatteFUNN recipients' position among and use of other public funding schemes.

Figure 2.15

Firms by additional sources of funding. Share of total. 2002-2015



Sources: Statistics Norway and Samfunnsøkonomisk analyse

2.8.1 Relative importance of other schemes

There are 12 365 unique limited liability firms (LLC) with an R&D tax credit (SkatteFUNN) in our data for 2002-2016.[12] Of these, 5 016 (41 percent) have not received support from any other scheme than SkatteFUNN. Compared to other schemes in our data, SkatteFUNN has a relatively low share of firms with support from other public schemes.

More than 70 percent of the firms in our survey rated SkatteFUNN as easier to apply for and having more reasonable reporting requirements, compared to other R&D-oriented schemes. Thus, most firms consider the scheme's administrative burden as low, compared to other schemes. Furthermore, SkatteFUNN is preferred by most respondents for its high rate of project approval and is considered the most well-adapted scheme for the respondents' needs and working practices.

Based on the respondents' assessment of the scheme, SkatteFUNN's relatively limited interaction with other schemes may be explained by the nature of SkatteFUNN; firms do not see the need to apply for public funding from other schemes.

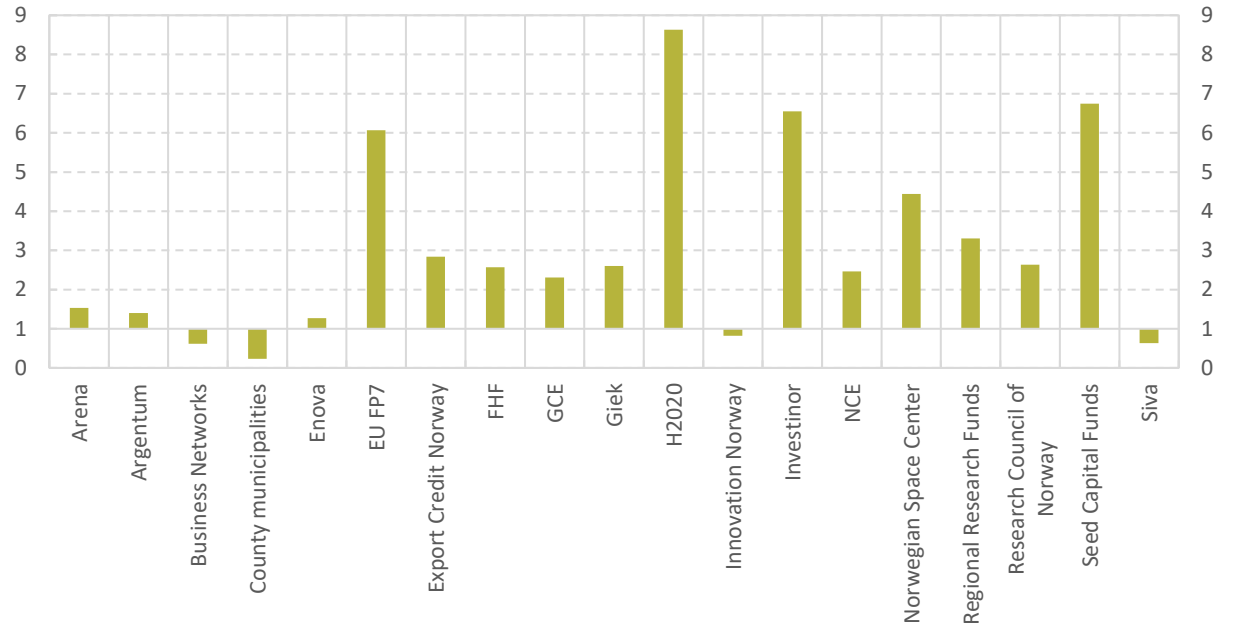
To assess which other funding agencies that seem to be important for the share of SkatteFUNN firms with support from others, we compare each agency's share of these firms with the agency's share of other supported firms (that have not received an R&D tax credit). Doing this, it is apparent that most funding agencies make up a larger share among recipients of SkatteFUNN than for other firms receiving public support (cf. Figure 2.16).

EU's 7th framework program (EU FP7) and Horizon 2020 stands out as other sources of funding for R&D projects among recipients of SkatteFUNN.[13] Other funding agencies support R&D, such as the Research Council, Regional Research Funds and the Norwegian Space Centre, also make up a relatively

[12] Samfunnsøkonomisk analyse has, commissioned by the Ministry of Trade, Industry and Fisheries, established a database for public support schemes. The database is a compilation of project data form 16 public funding agencies and allows us to identify public schemes' industrial and geographic distribution, as well as how they are distributed among firms and over time. Further, it makes it possible to map aggregated public funding of individual firms. In total, the database contains 649,749 recipient-year observations and cover the period 2000-2016. There are in total 13 223 unique recipients of SkatteFUNN. However, we restrict the sample to limited liabilities to ensure that the sample is comparable with the sample in the econometric analysis.

[13] These can be considered as the same source of funding, as Horizon 2020 is EU FP7's "successor".

Figure 2.16 Relative importance of funding agencies. Funding agencies' relative share.[1] Total[2] for 2000-2016.



Source: Samfunnsøkonomisk analyse

1) Relative share per agency indicates the relationship between the agency's share of firms in the sample (limited liabilities with R&D tax credit from SkatteFUNN) and the agency's share of all other limited liabilities with support from the respective agency. A factor greater than 1 indicates that the agency is "overrepresented" among SkatteFUNN recipients and vice versa.

2) Sample only include limited liability firms (excl. research institutes organised as limited liabilities). Schemes funding agriculture activities and energy efficiency measures are excluded

large share of the support to SkatteFUNN recipients.

In addition to being "overrepresented" among R&D-oriented schemes, funding agencies providing equity investments, such as Investinor and Innovation Norway's Seed capital funds, constitute a relatively large share among SkatteFUNN recipients that receive support from several sources.

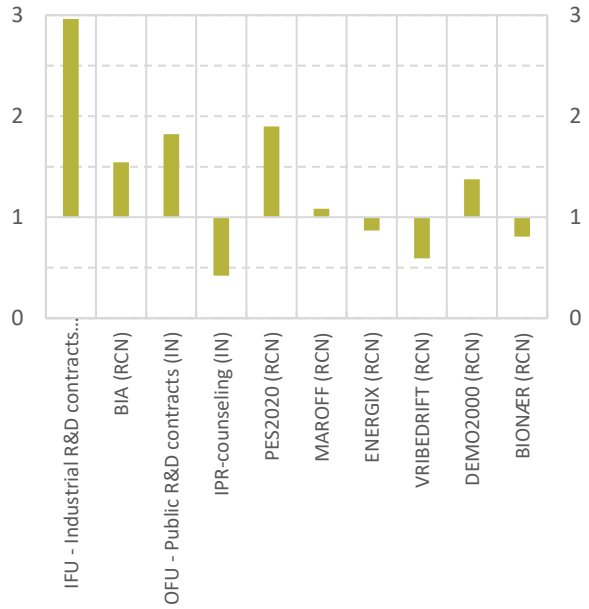
In our survey, respondents rate Innovation Norway's offers as most relevant, after SkatteFUNN, followed by the Research Council and private capital. Thus, it can seem somewhat surprising that Innovation Norway make up a smaller share among users of SkatteFUNN, compared to other firms. However, only firms that receive support from Innovation Norway, in addition to SkatteFUNN, is included in the calculation of the relative share. There may be several firms that consider Innovation Norway's schemes as relevant but that do not apply for or are granted support from their schemes.

That the abovementioned funding agencies, supporting R&D, are of relative importance to recipients of SkatteFUNN is most likely because firms that have approved R&D projects with funding from other sources also apply for SkatteFUNN. If we only look at schemes with similar objectives as SkatteFUNN, that is schemes aimed at increasing firm's R&D&I, the share of SkatteFUNN recipients only using SkatteFUNN increases to 65 percent.

Measured in number of SkatteFUNN recipients receiving support from other schemes with similar objectives as SkatteFUNN, Innovation Norway's "industrial R&D contracts" is the most used (cf. Figure 2.17). For most years this scheme has existed,

SkatteFUNN has been a prerequisite for receiving funding. The same holds for "public R&D contracts". Thus, interaction with these schemes is not surprising. Of the ten most used schemes, seven are R&D programs in the Research Council.

Figure 2.17 Top 10 public schemes for SkatteFUNN recipients (ranked by no. of firms from left to right). The schemes' relative share.[1,2] Total for 2000-2016[3]



Source: Samfunnsøkonomisk analyse
1) See explanation of the relative share in Figure 2.16
2) BIA, PES2020 - Project Establishment Support directed towards H2020, MAROFF - Innovation Programme for Maritime Activities and Offshore Operations, ENERGIX - Large-scale programme for energy research, VRIBEDRIFT - Regional R&D&I, DEMO2000 - Competitiveness in the oil and gas sector, BIONÆR - Sustainable Innovation in Food and Bio-based Industries
3) The period varies for the different schemes, but they have been available to all in the period they have existed

2.8.2 Changes in interaction with other schemes

As mentioned above, one could believe that SkatteFUNN would lead firms to apply for other types of public R&D funding. However, SkatteFUNN firms that receive support from other funding agencies are firms that also continuously use SkatteFUNN. It is not unusual to fund one project with support from both the Research Council and SkatteFUNN, if the funding is within the allowed limit for public funding. Given the latter, it is difficult to trace a firm's development along the so-called "research stair". If we look at which schemes the SkatteFUNN recipients have used before and after their first SkatteFUNN project, we don't find a significant change in the type of schemes they use. It may be possible to document a project or idea's advancement from SkatteFUNN, to application based research funding from the Research Council (or EU) and lastly support for commercialisation, but this beyond the scope of this evaluation.

It is worth mentioning that it is challenging to quantify changes in the use of public schemes adequately. Firstly, our data on support from public schemes starts in 2000. For firms that started their first SkatteFUNN project in 2002, the period of data is much longer after their first project than before. The increase in volume can therefore be a mere consequence of the number of years with the possibility of receiving support. Secondly, there has been an increase in the number of schemes offered by those funding agencies that have existed throughout the data period (Innovation Norway and the Research Council), as well as an increase in the number of funding agencies.

3 Public stimulus of R&D across Europe

It is internationally agreed upon that governments have a role in encouraging appropriate R&D levels and expenditures. R&D tax incentives are among the most popular innovation policy tools. In 2016, 29 of 35 OECD countries gave preferential tax treatment to firms with R&D expenditures. The majority of R&D tax incentives allow deduction of eligible R&D expenditure and several accredited schemes favour SMEs or young firms.

On average evaluation studies find that firms increase their R&D expenditure by more than the tax credit. Although it seems to be broadly agreed upon that R&D tax incentives result in increased R&D expenditure due to a reduction in the marginal cost of R&D investments, the results on the effectiveness of R&D tax incentives on innovation is mixed.

As elaborated upon in earlier chapters, it is generally agreed that governments have a role in encouraging appropriate R&D levels and expenditures. An increasing number of governments are therefore offering indirect support to increase spending on R&D through fiscal incentives. This can be in addition to or instead of direct support, for example through grants. R&D tax incentives are, internationally, among the most popular innovation policy tools. In 2016, 29 of 35 OECD countries gave preferential tax treatment to firms with R&D expenditures (OECD, 2016). The countries in Europe that have an R&D tax incentive scheme are shown as dark green on the map. The countries with a lighter shade of green do not have any R&D tax incentive scheme in 2017.

Essentially, the various schemes reduce taxes for firms that have R&D expenditure or income from commercialising intellectual property rights (IPR) (Straathof, et al., 2014). R&D tax incentives are typically considered indirect, as the choice of how to conduct R&D projects is left in the hands of the firm. Governments use tax incentives both as a tool to support broad R&D and as a targeted public policy to foster

innovation by firms with specific characteristics, such as small and medium-sized firms, energy, information systems, and others.

Although all R&D tax incentives aim to increase R&D in the private sector, they vary greatly. Broadly, they can be separated into input- and output-related R&D tax incentives. Input-related tax incentives decrease the cost of R&D inputs faced by firms, typically by reduced tax rates on firm income or social security taxes, proportional to R&D expenses.

Output-related R&D tax incentives increase the returns from innovative products that are protected by IPR. An example is patent boxes, under which income attributable to intellectual property developed through R&D is taxed at favourable rates.

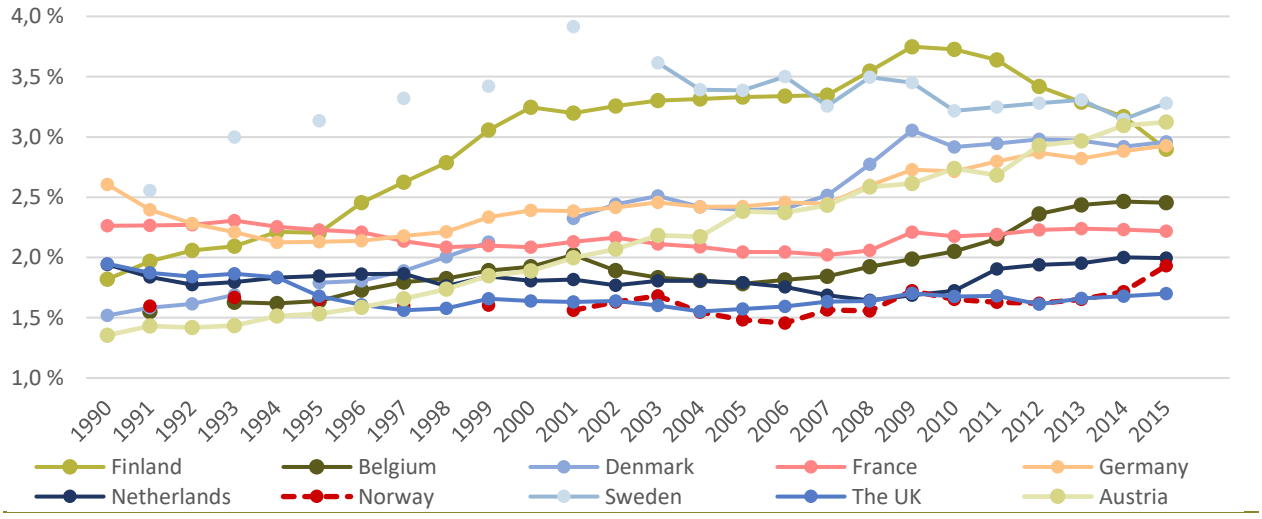
In this chapter, we will compare the features of R&D tax incentives across Europe. In general, the choice of R&D tax measure depends on country-level variables, such as overall innovation performance and the nature of the corporate tax system. At the end of the chapter, we will go through evaluations of schemes in France, Austria, The Netherlands and the UK. The schemes were selected to provide a broad overview of the variety of schemes.

3.1 Spending on R&D varies across countries

Figure 3.1 illustrates the development of gross domestic spending on R&D as share of GDP for selected countries. Domestic spending on R&D varies greatly between countries, but has been increasing in most since the financial crisis in 2008-09.

The European Commission has set 3 percent of GDP as an objective for each Member State's domestic spending on R&D, and of these 3 percent, two-thirds should be financed by the private sector. Most countries do not meet this target.

Figure 3.1 Share of gross domestic spending on R&D as a share of GDP



Source: OECD, Main Science and Technology Indicators

Figure 3.1 includes both public and private spending on R&D. It is interesting to note that our Nordic neighbours are among the biggest spenders on R&D in this selection of countries. This is even though Finland, Sweden and Denmark have relatively low governmental support of business R&D (Straathof, et al., 2014). Norwegian spending on R&D is at the lower range, with a share similar to

that of the Netherlands and the UK and closing the gap to France somewhat in the latter years.

Even though R&D expenditure as a share of GDP has increased in most countries in recent years, the evolution of privately financed R&D is relatively stable in most countries.

When it comes to R&D tax incentives, only a few European countries do not have a tax policy aimed at stimulating R&D, cf. the map on the previous page. These are Germany, Finland, Moldova, Luxembourg, Cyprus, Switzerland, Albania, Bosnia & Herzegovina, Ukraine, Belarus, and Estonia. Of countries within the EU only Germany, Finland, Bulgaria and Estonia does not have an R&D tax incentive. Germany is, however, planning to implement a R&D tax incentive in 2019.

The main advantages of R&D tax incentives are often argued to be low administrative costs, simple application process and neutrality along several dimensions (schemes typically do not target specific sectors or regions and firms can decide by themselves which projects to go for thus causing less distortive effects) (Cunningham, Shapira, Edler, & Gok, 2016).

However, there are also some disadvantages. Firstly, R&D tax incentives increase the government's budgetary uncertainty. Secondly, there is a risk that the additionality of R&D tax incentives is lower than with direct R&D funding, as some activities likely would have been carried out irrespective of the scheme.

The presence and extent of such advantages and disadvantages depend on the design of the scheme. In chapter 3.2, we elaborate upon different schemes.

3.2 Cross-country comparison of R&D tax incentives

The diversity of schemes makes a comparison across countries challenging. However, most explicitly target specific costs or activities related to R&D, and costs related to R&D personnel in particular.

Furthermore, tax credits are the most common form of R&D incentive, followed by allowances offset against income and accelerated depreciation for fixed assets used in R&D activities (Straathof, et al., 2014). Many countries also have patent boxes. Most tax incentives are based on corporate income taxes, whereas some are based on social security contribution.

The majority of R&D tax incentives are volume based

The majority of R&D tax incentives allow deduction of eligible R&D expenditure (volume-based schemes). A few schemes apply only to increases in R&D expenditure, for example over a year (incremental schemes).

However, incremental schemes were the initial choice of several countries for two reasons (Cunningham, Shapira, Edler, & Gok, 2016). Firstly, the main objective for public R&D support is to *increase* R&D, rather than to provide recurring support for existing R&D activities. It was therefore argued by Cunningham et al. (2016) that an incremental scheme is the most efficient to reach the objective. Secondly, it is arguably easier to identify and avoid misuse of the scheme if it is incremental. With a system based on increased R&D expenditure, and not total volume, it is not possible over the long term to over- or underestimate R&D expenditure. Despite these arguments, incremental schemes are considered too complex, which is why most countries have moved towards volume-based schemes.

R&D tax incentives typically favour smaller firms

The generosity of the schemes also varies, both when it comes to the percentage of R&D expenditure that can be deducted and the maximum amount that can be claimed. The generosity of R&D tax incentives is inherently linked to the design of tax incentives as well as firm characteristics. The percentage of R&D expenditure that can be deducted from the tax burden with the headline R&D tax credit rate varying from 10 percent in Italy, 12 percent in Austria, 18 percent in the Netherlands, 20 percent in Norway, to close to 30 percent in Spain and France (Cunningham, Shapira, Edler, & Gok, 2016). When it comes to R&D tax allowances, governments determine a multiplier for R&D expenditure that can be deducted from taxable income. In the UK the multiplier is 130 percent.

When it comes to the maximum amount of tax reduction that can be claimed, several countries have implemented a cap, as with SkatteFUNN, whereas others do not have a limit, for example Austria. The cap can either be an absolute ceiling or a threshold where the tax rate changes for expenditure above the threshold.

While tax incentives are essentially a generic policy instrument, targeting specific groups of firms is quite common. The schemes often differentiate their level of generosity by firm type, type of R&D activity, region or sector. There is a significant variation in the generosity of R&D tax incentives for firms of different size and profitability. Some countries, like Norway, have different tax deduction rates depending on the size of the firm, whereas others have different rates depending on the scope of the firm's R&D expenditure.

The rationale behind the support is typically to alleviate difficulties to increase the returns on R&D investments, which is more prevalent for SMEs and start-ups. Therefore, it is common for the tax schemes to target SMEs and/or young firms, by offering them more generous tax advantages. The Netherlands and the UK, are examples of countries, other than Norway, whose R&D tax incentives favour SMEs.

Tax credit schemes can apply to firms that make a profit in the same year as the R&D expenditure, or there can be options to carry tax credits backward or forward. Such features offer firms more flexibility and certainty in investment decisions. Another option, which is included in SkatteFUNN, is that claims can be disbursed even if the firm is not making a profit. Another example is Skattekreditordningen in Denmark, which was implemented as a counter-cyclical measure to combat the economic recession (Straathof, et al., 2014). The scheme targets R&D expenses of loss-making firms. A similar scheme was implemented as a counter-cyclical measure in France as well. Indirectly, such an approach shifts the support to young and small firms. The idea was that the disbursements would particularly strengthen the liquidity of SMEs in the start-up phase, before R&D activities resulted in income.

Figure 3.2 illustrates how the tax subsidy rates on R&D expenditure varies between countries and by firm size and profitability. The higher the tax subsidy rate, the more favourable the scheme. The tax subsidy rates on R&D expenditure is measured as one minus the B index.[14] Algebraically, the tax subsidy rate is defined as:

$$\tau = 1 - \frac{1 - A}{1 - t}$$

[14] The B index is a tool for comparing the generosity of the tax treatment of R&D in different countries. Algebraically, the B index is equal to the after-tax cost of spending on R&D divided by one minus the corporate income tax rate. The after-tax cost is the net cost of investing in R&D, considering all the available tax incentives. The more favorable a country's tax treatment of R&D, the lower its B index. The computation of the B index requires some simplifying assumptions. Its "-synthetic" nature does not allow for distinguishing the relative importance of the various

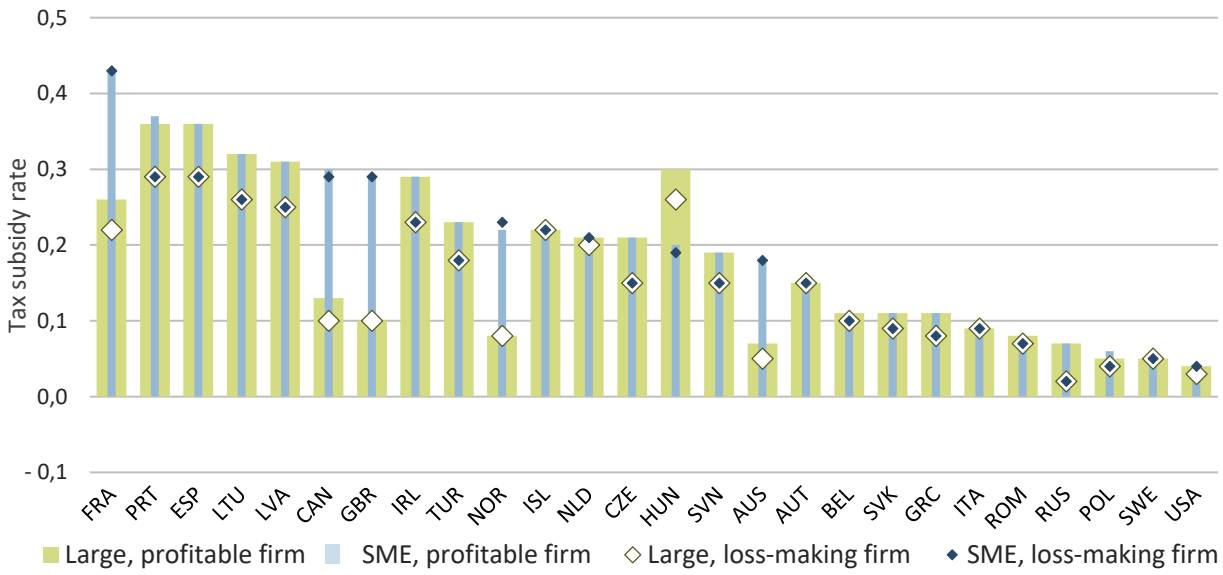
Where τ is the tax subsidy rate, $1 - A$ is the after-tax cost of spending on R&D, and t is the corporate income tax rate. The after-tax cost is the net cost of investing in R&D, considering all the available tax incentives.[15]

The OECD median tax subsidy rate is estimated to 0.19 for profitable and to 0.13 for loss-making SMEs, above the OECD median of 0.13 for large profitable firms and of 0.10 for large loss-making firms (OECD, 2016). This result is attributable to the preferential tax treatment that 12 of 28 OECD countries currently provide for SMEs and/or young firms vis-à-vis large firms.[16]

Taking France (FRA) as an example, the tax subsidy rate of 0,43 for the SME segment tells us that the marginal cost of investing in R&D is 57 percent of the cost of regular investments. Equally, it tells us that the firm receives € 0,43 for R&D expenditures of € 1.

In 2016, France (FRA), Portugal (PRT) and Spain (ESP) had the highest tax subsidy rates for SME's, in both the profit-making and loss-making scenarios. The difference between the tax incentive in these countries can be analysed by comparing the lines and diamonds in the figure. When the dark blue diamond is showing a higher tax subsidy rate than the white diamond, it means that the country's R&D tax incentive(s) favour SMEs to large firms. Tax incentives can be more generous for SMEs and/or young firms than for large firms. This is to a large extent the case for France as well as Norway (NOR) and Great Britain (GBR).

Figure 3.2 Tax subsidy per € of R&D expenditures for selected OECD countries, by firm size and profit scenario in 2016.



Source: OECD, 2016

policy tools it considers (*e.g.* depreciation allowances, special R&D allowances, tax credit, CITR). Some detailed features of R&D tax schemes (*e.g.* refunding, carry-back and carry-forward of unused tax credit, or flow-through mechanisms) are for example not considered. Model is confined to tax measures related specifically to the R&D decision at the corporate level. Some countries may offer no R&D tax incentives but compensate for this by taxing investment income very lightly. The B index should therefore be examined together with a set of other relevant policy indicators.

[15] If a country does not have a R&D tax incentive, the B index is at least one, and the tax subsidy rate is zero or negative.

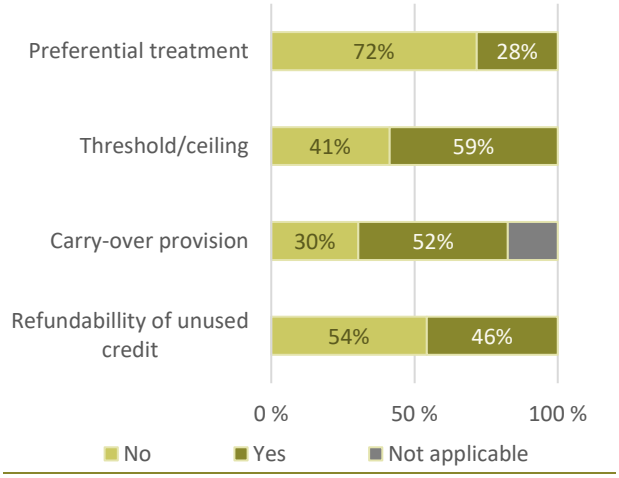
[16] The only country who provides preferential tax treatment to larger firms is Hungary.

In contrast to SkatteFUNN, some countries, for example Sweden, Austria and the Netherlands, target the firm's legal status. The R&D tax incentive can for example be less generous for foreign-owned firms.

Some schemes also differentiate between sectors or industries, typically favouring sectors that are considered of strategic importance or having economic difficulties (Cunningham, Shapira, Edler, & Gok, 2016). According to the EU competition law, it is not legal to target specific sectors with R&D tax incentives. However, it is possible to target specific fields of R&D, such as green technology – which is favoured in Belgium. Under such a design, the scheme becomes complex and might cause distortions in the sense that firms might have an incentive to adapt their activity to be eligible for the scheme.

Collaborative R&D, typically relating to basic research, are also often supported by tax incentive schemes. This is because basic research is assumed to be associated with a potential for large external benefits. Figure 3.3 summarises R&D tax incentives across the OECD countries.

Figure 3.3 Design of R&D tax incentive relief across the OECD. Share of schemes subject to relevant provisions.



Source: OECD, Measuring R&D Tax Incentives, 2015

Figure 3.3 illustrates that 28 percent of tax incentive schemes does have preferential treatment based on firm characteristics, typically preferential treatment of SMEs. Close to 60 percent of schemes have ceilings or thresholds, typically related to the amount spent on R&D. Furthermore, 52 percent of the schemes offer carry-over provisions to make planning of investment expenditure easier for firms. 46 percent have an option of refundability of unused credit, such as SkatteFUNN.

SkatteFUNN in a Nordic perspective

Among the Nordic countries, Denmark, Iceland and Norway have volume-based tax credits redeemable against corporate income taxes, whereas Sweden's tax relief is redeemable against social security contribution expenses. Finland abolished its R&D tax allowance scheme in 2015.

Sweden offers an R&D tax incentive in the form of a reduction of the social security contribution of employees engaged in R&D projects. Straathof et al. (2014) argues that Sweden appears to have the most 'unique' R&D tax incentive system, as it does not match with any other one country.

Denmark offer two R&D tax incentive instruments; tax credits including enhanced allowance and accelerated depreciation on R&D capital. The tax incentives account for about 60 percent of total public support of firm R&D.

Firms in Denmark have been able to deduct their R&D capital expenditure in full in the year of acquisition of R&D capital (e.g. machinery and equipment) since 1973. Straathof et al. (2014) highlight the accelerated depreciation scheme as particularly good, due to its organisational practice and that it does not target specific groups of firms.

Skattekreditordningen in Denmark, was implemented as a counter-cyclical measure to combat

the economic recession by compensating firms for a temporary lack of external finance (Straathof, et al., 2014). The scheme targets R&D expenses of loss-making firms, and provides options of carrying losses or gains forward or cash refunds.

The Finnish R&D tax incentive scheme was intended as temporary from the outset, and was abolished because an evaluation found that the scheme failed to reach its objective (Kuusi, Pajarinen, Rouvinen, & Valkonen, 2016). Under the scheme, firms were eligible for corporate tax deduction on labour expenses incurred when undertaking R&D activities.[17] Kuusi et al. (2016) explain that the utilisation of the scheme by Finnish firms was limited. The claimed deduction was very low, and the forgone tax revenue just 8 percent of what was expected by the authorities. Seemingly, loss-making firms were not interested in using the deduction even though carry forward of losses due to increased R&D was possible. The liquidity concern could have been assessed by designing a subsidy allowing an immediate reduction of R&D labour costs, as in Sweden, or a negative tax as in Norway and Denmark. In Finland, benefitting from the subsidy was conditional on future profitability.

Kuusi et. al. (2016) concluded that the R&D tax incentive failed as a supplement to the Finnish, mainly subsidy-based, innovation system and that the impact remained rather small. Furthermore, firms that received direct subsidies reported more often that they had started new or expanded their old R&D. Kuusi et al. (2016) further concluded that the magnitude of the scheme should have been much larger to achieve a tangible effect on economic growth. As a policy experiment the scheme was also criticised for not providing test conditions that allowed a rigorous, econometric analysis of its impacts.

Table 3.1 summarizes the characteristics of the R&D tax incentives in the Nordic countries.

Table 3.1 Overview of R&D tax incentives in selected Nordic countries

	Norway	Sweden	Finland	Denmark
R&D tax incentive	*SkatteFUNN*	*Skatteincitament för FoU*	*Corporate R&D Tax Relief*	*Skattekreditordningen*
Type of scheme	R&D tax credit	SSC reduction	R&D tax credit (Abolished)	R&D tax credit for loss-making firms
Eligible base	Volume of R&D tax expenditure	Labour cost	Volume of R&D tax expenditure	Volume of R&D tax expenditure
Differentiation between SME and large firms	Yes. 20 percent tax deduction for SMEs, and 18 percent for large firms.	No. 10 percent deduction for all firms.	No. 100 percent tax deduction for all firms.	No. 22 percent tax deduction for all firms.
Ceilings	€ 10 million cap per year. € 12 million cap for R&D subcontracted to approved public research organisations.	SSC deductions capped at SEK 230,000 per month and firm. The resulting SSC must be at least equal to the old age pension contribution.	€ 400,000 cap in terms of eligible amount of R&D.	R&D expenditure ceiling at DKK 25 million. Maximum tax credit that can be given is DKK 5.5 million (22% of DKK 25 million).
Refund/ carry over	Yes, refund for firms that are not tax liable	Yes, immediate refund. No carry over.	Refund not applicable. No carry-forward, 10 years carry-back.	Immediate refund for all firms. No carry over.
Eligible firms	Available to all firms registered in Norway	Not available for self-employed, partners in a trading partnership and public employers.	All limited liability firms and cooperatives.	Corporations and self-employed with deficit related R&D expenses.

[17] The tax credit could be applied for new projects, and the project-specific deduction was 15.000–400.000 euros. The incentive excluded the use of other subsidies. The tax deduction could be carried over into future tax years.

3.1 Evaluations of foreign schemes

The rising popularity of R&D tax incentives has been accompanied by a surge in the number of studies finding strong correlations between R&D tax incentives and increased R&D spending in the private sector.[18] Although it seems to be broadly agreed upon that R&D tax incentives result in increased R&D expenditure due to a reduction in the marginal cost of R&D investments, prior empirical research has yielded mixed results on the effectiveness of R&D tax incentives on innovation.

Throughout the remainder of this chapter, we will go through the main approaches for evaluating tax incentives and the main conclusions from the most relevant evaluations. They were selected to provide a broad overview of the variety of schemes. Furthermore, tax incentive schemes from a selection of particularly relevant countries will be presented more thoroughly. These reviews will go through the main characteristics of the schemes and the major findings of the impact evaluations.

3.1.1 Evaluating of R&D tax incentive schemes – alternative approaches

Comparing the effectiveness of R&D tax incentives between countries is a challenging task. Most R&D tax incentives have not been evaluated quantitatively, making it impossible to compare them directly. However, the relatively recent availability of high quality registry based data, have enabled more precise evaluation of the impact of tax incentives (Guceri & Liu, 2017). Even if a scheme has been thoroughly evaluated, the results are not necessarily externally valid due to differences in framework conditions (Straathof, et al., 2014).

Quantitative evaluations of R&D tax credit schemes typically utilise two main approaches that both predict input additionality through different firm-, time- and location-specific factors. A few studies also estimate the output additionality, i.e. the schemes' actual impact on innovation. Input additionality is defined as the firms' R&D expenditure that can be attributed to the policy intervention relative to the size of the tax credit itself. The difference between the approaches lies in which variables are used to measure the presence of the scheme. Each approach has its own set of assumptions on which the demand for R&D is based. Each approach also has its own econometric challenges.

The first approach evaluates the input additionality by assessing the elasticity of R&D expenditure with respect to the user cost of R&D capital. The elasticity measures the firm's response to changes in a price index of R&D inputs. The user cost of capital can be defined as the actual cost of R&D faced by firms, where an R&D tax incentive is one of the determinants. The wage rate of researchers and the price of equipment are other determinants (Hall and Van Reenen, 2000). If a firm spends everything it saves on taxes on R&D expenditure, the input additionality is equal to one; if the firm spends more than it receives as a tax credit, input additionality is larger than one, and vice versa.

In the second approach, R&D expenditure is regressed directly on a variable capturing the presence of the R&D tax incentive. The estimated coefficient on the tax incentive usually can be directly interpreted as the input additionality of the scheme.

Whether tax incentives are efficient as R&D policy ultimately depends on how many innovative products, services, and production processes they induce, not on whether R&D expenses increase. The output additionality is therefore of greater importance than the input additionality. Unfortunately,

[18] See for example Hall & Van Reenen (2000).

the causal impact of R&D tax incentives on innovation and productivity has rarely been studied. The limited knowledge that exists seems to point towards a positive impact on innovation.

3.1.2 Main conclusions of evaluation studies

Irrespective of approach, the majority of evaluations of R&D tax incentive schemes conclude that they are effective in stimulating investment in R&D (Straathof, et al., 2014). On average the studies find that firms increase their R&D expenditure by more than the tax credit (Hall & Van Reenen, 2000; Arundel, Bordoy, Mohnen, & Smith, 2008). Several econometric studies have found that one euro of foregone tax revenue on R&D tax credits raises expenditure on R&D by about one euro (Hall & Van Reenen, 2000; Mairesse, Mohnen, Simpson, & Warda, 2008; Lokshin & Mohnen, 2012; Mulkay & Mairesse, 2013; Bloom, Griffith, & Van Reenen, 2002). This implies that the input additionality is larger than one.

However, the impact estimates vary widely and are not always comparable across countries due to differences in the schemes and the applied methodology (Straathof, et al., 2014; Köhler, Laredo, & Rammer, 2012; Ientile & Mairesse, 2009). In a meta-analysis by Ientile and Mairesse (2009) it is argued that studies with lower standard errors have a lower input additionality. Furthermore, the meta-analysis by Gaillard-Ladinska, Nonand Straathof (2014) shows that reported estimates are often inflated substantially due to publication selection bias.[19] When accounting for this bias, the effect on R&D expenditure is positive but modest.

Only a few studies have tried to estimate the output additionality. In addition to the previous evaluation of SkatteFUNN, Cappelen et al. (2007), Czarnitzki, Hanel, and Rosa (2011) found a significant impact of the Canadian R&D tax credit on innovation.

The effect of R&D tax incentives on R&D expenditure varies across sub-groups of firms, with most studies focusing on firm size. In some of the countries analysed, SMEs seem to respond more strongly to the support, while the reverse has been found in other countries. There is some evidence that the impact for start-up firms can exceed the average impact. These seemingly contradictory results make it difficult to draw any clear conclusions.

Lokshin and Mohnen (2008) and Hall and Van Reenen (2000) note that even though it is important to estimate expenditure on R&D per euro in forgone tax revenue, this does not replace social cost-benefit analyses. Even if the increase in R&D expenditure per forgone tax revenue is below one, the scheme may still generate higher welfare due to positive spillover effects.

Recent evidence suggests that knowledge spillovers of large firms exceed those of small firms (Straathof, et al., 2014). This finding weakens the case for targeting tax incentives towards SMEs. On the other hand, SMEs increase their R&D expenditure more strongly in response to incentives.

Recommended characteristics of schemes

The impact of R&D tax incentives is highly sensitive to their design and organisation, as well as other national characteristics. However, thorough empirical studies are scarce.

One aspect that is relatively well-studied, is whether incremental schemes are more effective than volume-based schemes. Both have been found to result in additional R&D expenditure. However, Straathof et al. (2014) concluded that volume-based

[19] Stanley (2008) define Publication selection bias or the "file drawer problem" as "the consequence of choosing research papers for the statistical significance of their findings". Publication bias also applies to individual estimation results when they are not reported by researchers because of their statistical insignificance or magnitude.

schemes are more effective than incremental ones. Incremental schemes may more effectively trigger additional, new research, but they may also trigger firms to change the timing of their R&D investments, and may result in higher administrative and compliance costs. As incremental schemes have not been found to stimulate R&D more effectively than volume-based schemes, the higher costs of incremental schemes would seem to suggest that volume-based schemes are to be preferred. This supports that, and may also explain why, the vast majority of schemes are volume-based. Furthermore, Köhler et al. (2012) conclude that volume-based incentives appear to have the largest effect on R&D expenditure, i.e. input additionality.

Another argument by Straathof et al. (2014) is that R&D tax incentive schemes ideally should apply to the types of expenditures that bring about the largest knowledge spillovers. Schemes based on personnel costs for researchers can be considered best practice in this context, mainly because researchers move from one employer to another, spreading knowledge. Tax credits for researcher wages can for example be found in The Netherlands, Sweden and Belgium (Straathof et al., 2014).

Furthermore, Straathof et al. (2014) recommend that tax incentives target young firms, rather than SMEs in general. This assumes that young firms are more likely to be innovative. The French R&D tax incentive scheme explicitly targets young firms, and is referred to as best practice by the European Commission (Straathof, et al., 2014).

Straathof et al. (2014) point out that R&D expenditure may precede revenue generated by innovation by several years. Therefore, it is viewed as good practice to provide a carry-over facility and an option to receive the benefit even if a firm is not profitable. Such features offer firms more flexibility and certainty in investment decisions. This is especially relevant for young firms that typically are not profitable in their first years of operations.

While most of the R&D tax incentive schemes analysed have a carry-over facility, cash refunds are available only in nine countries, including in Norway.

The second highest ranking tax incentive in the European Commission's study is SkatteFUNN. This is mainly due to the non-bureaucratic and generic design of the scheme. SkatteFUNN is praised for having a one-stop, online application procedure.

In addition, SkatteFUNN's enhancement of collaboration between private firms and public research institutes is highlighted as an important characteristic. Collaboration between the private sector and research institutes often creates external benefits (Dumont, 2013).

3.1.3 Summary of schemes in selected countries

This chapter will go through the main characteristics of schemes and findings of impact evaluations in selected countries.

The French tax credit scheme for young innovative firms is included because it is ranked the highest in the European Commission's comparison of 80 different R&D tax incentive schemes. It provides a generous tax credit to young SMEs, whose R&D expenditure represents at least fifteen percent of their total costs.

The tax incentives in the Netherlands are also included as an example of good practice. The accreditation stems from their general character, wide scope of eligible types of R&D expenditure, and efficient administration. Furthermore, a special preferential rate is offered to young firms. Moreover, firms that do not make profit can still enjoy the benefit, which means that it is especially attractive to young

firms. Although Austria spends a larger share of GDP on R&D than Norway, it is comparable to Norway both in size of the economy, tax rates and in tax incentive schemes for R&D. Furthermore, the scheme was recently evaluated.

United Kingdom's R&D tax relief schemes, like Norway's, have different headline rates for SME's and large firms Another similarity is relative simplicity and easy application procedures. Firms have easy access all necessary information about the instrument's design, changes made and prospected, as well as practical information about application procedure and possible enquiries that may be made.

Table 3.2 summarise the characteristics of the R&D tax incentives in the different countries.

Table 3.2 Overview of R&D tax incentives in selected European countries

	France		Netherlands	Austria	UK	
R&D tax incentive	*Crédit d'Impôt Recherche (CIR)*	*Le régime de la jeune entreprise innovante (J.E.I.)*	*Wet Bevordering Speur- & Ontwikkelingswerk (WBSO)*	*Research Premium (Forschungsprämie)*	*Corporate tax credit for R&D*	*R&D expenditure credit (RDEC) scheme*
Type of scheme	R&D tax credit	SSC reduction	R&D tax credit & SSC reduction	R&D tax credit	R&D tax credit	R&D tax credit
Eligible base	Volume of R&D tax expenditure	Labour cost	Volume of R&D tax expenditure and labour cost	Volume of R&D tax expenditure	Volume of R&D tax expenditure	Volume of R&D tax expenditure
Differentiation between SME and large firms	No. 30% headline tax credit rate, and 50% for firms in French overseas territories with R&D expenses up to €100 million, 5% for R&D expenses over €100 million.	Yes. 100% for SME, and no exemption for large firms. The exemption from SSC is available for 8 years for firms holds the JEI status.	No. 32% for eligible R&D costs up to € 350k, 16percent above € 350k	No. 12% deduction.	Yes. 30% for large firms. 130percent for SME.	Yes. 11% for large firms. Not applicable for SME.
Ceilings	€ 10 million cap per year. € 12 million cap for subcontractions to approved public research organisations.	4.5 times the minimum salary or 5 times the annual social security ceiling (€ 187,740 in 2014).		Subcontracted research expenditures are limited to € 1 million.	SME: Upper limit of €7.5 million per R&D project. No limit for large firms.	None.
Refund/ carry over	Large firms' claim may be used to pay income tax in the following three years. Immediate refund for SMEs.	Immediate refund to SMEs. Large firms not eligible.	Immediate refund for all firms. Carry-forward 1 year.	Immediate refund for all firms. No carry over.	Immediate for SME. Indefinite carry-forward, no carry-back.	Immediate refund. Indefinite carry-forward.
Eligible firms	Available to all tax liable French and foreign firms with R&D expenditures.	Less than 8 years old SMEs dedicating at least 15% of expenses to R&D (establishment must not be a result of restructuring).	All Dutch firms and self-employed entrepreneurs carrying out R&D projects. Public knowledge institutes are not eligible.	Any tax liable firm carrying out R&D activities within Austria or contracting it out to third parties within EEA.	All SMEs	All large firms

The French tax incentive scheme targets young firms

Investment in R&D is one of the top priorities of French economic policy. Still, R&D in the private sector is relatively low and stable. This primarily reflects the sectoral composition of the economy, where high-tech manufacturing sectors represent only a modest share. This is also the result of an insufficient engagement of firms of intermediate size in R&D activities (European Commission, 2013).

Although, the extent of spending on R&D in the private sector has not changed remarkably since the mid-2000s, the scope of R&D tax credits has increased. The increase is in particular due to the implementation of a more generous regime of tax credits in 2008, after a long period of just minor changes in generosity since 1983, when CIR (Crédit d'Impôt Recherche (CIR)) was implemented. The CIR scheme was initially incremental, but was turned partly into a volume-based scheme in 2004. The reform in 2004 also consisted of the implementation of the volume-based *Young Innovative Firms Program* (JEI, "Jeunes Entreprises Innovantes"). In 2008, the CIR scheme was made completely volume-based. Virtually all R&D performers in France now use the CIR. It is, however, the JEI scheme which is viewed as best practice by the European Commission (Straathof, et al., 2014).

JEI targets young innovative firms that are defined as independent SMEs. The firms must be younger than eight years and their R&D expenditure must amount for at least 15 per cent of their total expenses. The scheme avoids some possible unwanted tax adjustments as firms that have been created because of restructuration of others (that would not qualify as JEI), or that are formed as an extension of existing firms, are excluded.

The scheme is non-discriminatory in terms of sectors and geography. Firms can also receive an immediate refund and benefit from the scheme, even if they do not make a profit.

The scheme offers a wide range of different tax breaks, including reduced corporate and local taxes, as well as social security contributions.[20] A maximum amount that a firm can receive was introduced in 2011.[21] From January 2012, the first year of participation in the scheme gave exemption from corporate income taxes. In the second year, firms receive a 50 percent reduction in the corporate tax. Starting from the third year, no corporate tax discount is given. The rate of benefit available from social contributions was increased in 2012, offering firms to be exempt from the contributions in the first four years, and then gradually decreasing to a 50 percent discount. The ceiling of the benefit per establishment was also increased to five times the amount of the annual social security contributions.

Starting January 2014, the rate of benefit for social security contributions was further increased. Qualifying firms are now exempt from social security contributions for the whole eight-year period.

Furthermore, by decision of local authorities, firms having JEI status may be exempt for seven years of property tax on buildings and territorial economic contributions.

The qualifying R&D activities are defined according to OECD's Frascati Manual that includes basic and applied R&D. According to the manual, qualifying

[20] Since its introduction, the offered rates of discount have been amended various times. Up till the end of 2010, firms were exempt of social security contributions for the first eight years of JEI participation, and from corporate tax liability for the first three years. In the fourth and fifth year it offered a 50 percent reduction in the corporate tax rate. In 2011, the social security contribution benefits were decreased, offering tax exemption in the first four years, and then gradually decreasing to 10 percent discount.

[21] This implies that the benefit cannot exceed € 200,000 over three fiscal years. Per salary the maximum amount that can be received is 4.5 times the minimum salary; per establishment- three times the ceilings of social security contributions, being € 106,056 in 2011.

R&D expenditure covers a wide base of eligible expenditure, including "*acquired property directly targeted at R&D activities, R&D personnel costs, a fixed share of operating costs, expenditure for conducting similar operations entrusted to public research organizations or universities, private research organizations approved by the Ministry of Higher Education and Research, or approved scientific or technical experts under the same conditions; costs of maintaining and registering patents; and depreciation and amortization of patents acquired to conduct R&D activities*".

The tax incentives' impact in France

While spending on R&D in the private sector fell in most European countries during 2009, it increased in France (Freitas, Castellacci, Fontana, Malerba & Vezzulli 2017). This indicates that there may be a positive impact of the French schemes. The CIR scheme is claimed to reduce the cost of a researcher by one third, effectively making the French researcher among the most cost efficient in the world.

Both the CIR and the JEI tax incentive schemes have been evaluated. JEI was evaluated by Hallépée and Garcia (2012). Using a matching technique, they analysed firms with very similar characteristics that had and had not participated in the scheme. They found that implementing the scheme led to an 8.4 percentage point increase in employment for participating firms between 2002 and 2005, as well as an increase in survival rate and higher wages. When considering the period between 2004 and 2009, they found that participating firms appeared to have had increased growth in sales and in value added. However, they also found that less than half of participating firms made a profit. Nevertheless, they concluded that the increased R&D investments by participating firms were higher than the forgone tax revenue.

Lelarge (2009) analysed the scheme's impact on wages and concluded that the JEI scheme has a six times higher effect on wages than conventional R&D tax credits. Furthermore, it was argued that payroll tax rebates are likely used to retain high-skilled researchers.

Duguet (2010) used a matching technique to evaluate the CIR scheme at the time when it was fully incremental. Input additionality was estimated at 2.33 (relative to the forgone tax revenue) over the years 1993 to 2003 when the control group was firms not using the scheme. When restricting the control group to firms with R&D activities, but not utilising the scheme, the additionality disappeared. Hence, there was no clear evidence of additionality of the incremental R&D tax credit scheme.

Lhuillery et al. (2013) also used a matching technique to estimate the input additionality of the CIR scheme between 1998 and 2009. They estimated that the input additionality is between 1 and 2.6. During this period the scheme became volume-based.

Mulkay and Mairesse (2013) studied the R&D tax credit scheme in the period between 2000 and 2007, which is the period leading up to the 2008 reform. They applied three different techniques (fixed effects, first differences and generalized method of moments) and found a long-run elasticity of R&D capital with respect to the user cost of R&D capital of -0.2.[22] This means that a decrease in the user cost of ten percent will induce a level of R&D capital that is two percent higher. In addition, they simulated the expected effects from the 2008 reform and

[22] The elasticity measures the firm's response to changes in a price index of R&D inputs. The user cost of capital can be defined as the actual cost of R&D faced by firms, where an R&D tax incentive is one of the determinants.

concluded that in the long run the reform would stimulate R&D expenditure by 12 percent.[23] This corresponds to a long-run input additionality of 0.7. In 2004, Mulkay and Mairesse estimated the scheme's input additionality to between 2 and 3.5.

Freitas et. al. (2017) found positive input and output additionality effects of the CIR scheme in the whole sample of French firms. Furthermore, they concluded that French firms in more centralised areas on average have a higher propensity to receive tax credits and stronger input additionality effects. Output additionality effects were found not to be significantly different across industries. Taken together, these results imply that highly centralised areas are also those where one may expect a higher average increase in innovation output.

The Netherlands is moving towards more R&D incentives

The Netherlands is amongst the countries with the largest support for private sector R&D, in terms of volume. Tax incentives account for 89 percent of total public support for R&D in the private sector (Appelt, Bejgar, Criscuolo, & Galindo-Rueda, 2016). This is equivalent to 0,16 percent of GDP.

The Netherlands actively promotes engaging in R&D activities through a favourable corporate income tax regime and specific R&D tax incentives available to firms operating in the Netherlands. The Netherlands was also amongst the very first countries to implement the so-called patent box.[24]

The tax incentive scheme in the Netherlands, *Wet Becording Speur & Ontwikkelingswerk* (WBSO), is volume-based. The scheme was implemented in 1994 and provides tax relief through a payroll withholding tax credit (Straathof, et al., 2014), implying that the scheme reduces wage costs of R&D personnel, rather than corporate income tax. The tax relief is limited to the payroll tax liability of the corresponding tax period. The headline credit rate is 32 percent for R&D costs up to€ 350 000 and 16 percent above. Unused claims can be carried forward to subsequent tax periods.

For non-personnel costs, a complimentary scheme, called R&D allowance (RDA), is available. In case a firm does not have taxable income, it can carry back the expenditure one year or forward up to nine years. For self-employed persons, the carry back is available for three years and carry forward for nine years. Only projects that have been approved for WBSO can also qualify for RDA.

The tax incentives' impact in the Netherlands

The WBSO has been evaluated on different occasions and the studies have found relatively large and significant benefits. The studies have found an input additionality above 1 (Straathof, et al., 2014). Poet et al. (2003), for example, estimated an input additionality of 1.02 between 1997 and 1998.

Lokshin and Mohnen (2013) utilised firm-level microdata to analyse the impact of WBSO on the wages of R&D personnel. Their main empirical finding was that there is a significant price effect of the R&D tax incentive scheme on the wages of R&D personnel. They estimated a short-term input additionality of 3.24 for small firms and 1.05 for large firms. The long-term input additionality was found to be 1.21 for small firms, but only 0.42 for large firms.

The evaluation by Cornet and Vroomen (2005) is the only WBSO evaluation that has used a quasi-experimental design. They found that the scheme

[23] French R&D tax credit (CIR) was fully incremental until 2004, when the volume based part was introduced alongside. It was then reformed to be fully volume-based in 2008.

[24] Patent Box is a form of R&D tax incentive where the corporate tax rate on profits generated from patents are reduced.

yields large positive benefits for start-ups. The extension of the first tax bracket in 2001 was found to have a smaller, but still positive, effect. On average a euro spent in terms of foregone tax revenue induced between€ 0,5 to€ 0,8 of additional labour expenditure. The extension of the tax bracket, however, showed that every euro in forgone tax revenue resulted in only € 0,1 to € 0,2 spent on labour costs. Straathof et al. (2014) argues that the study by Cornet and Vroomen is a good (and rare) example of a study that uses difference-in-difference with properly defined control group.

Although the input additionality is generally above one, the estimated costs of this scheme seem to outweigh these benefits. Lokshin and Mohnen (2013) compared the additionality with the forgone tax revenue and concluded that welfare losses can amount to 85 percent of the forgone tax revenue. This is mainly because volume-based schemes are more likely to support activities which would have been carried out anyway.

Austria provides tax relief through a volume-based R&D tax credit scheme

Austria offers a diversified funding landscape for firms engaged in R&D, including both tax incentives and subsidies. About 50 percent of the public support of R&D in the private sector, stems from an R&D tax incentive. Combining public and private spending on R&D, Austria's spending is above the European target and amounted to 3,1 percent of GDP in 2016.

Although Austria spends a larger share of GDP on R&D than Norway, it is comparable to Norway both in size, tax rates and in tax incentive schemes for R&D.[25] Austria's R&D tax credit scheme, called *Research premium (Forschungsprämie),* is volume based. The scheme was introduced in 2002, and has since 2011 been the only tax incentive scheme in Austria to promote R&D.[26]

The R&D tax credit can be claimed by any firm that carries out research activities in Austria, regardless of firm size, industry or legal form. Just as with SkatteFUNN, firms can receive a refund of unused credits in the case of insufficient profit. There is no carry-over opportunity.

Furthermore, the *Research premium* differs from SkatteFUNN in that it only has a ceiling for subcontracted R&D.[27] There is no ceiling for R&D costs eligible for tax credit. The main difference between the *Research premium* and SkatteFUNN is that where SkatteFUNN targets SMEs through a higher tax deduction rate, the *Research premium* has a flat rate of 12 percent.[28]

Over the years, the rate has continuously been increased – most recently in 2016 to 12 percent. In 2015, R&D expenditure of almost € 502 million was claimed under the scheme.

The tax incentives' impact in Austria

Falk et al. (2009) used a probit model to estimate the scheme's output additionality between 2005 and 2007. They concluded that the use of R&D tax incentives does increase the probability of introducing new products.

There is a recently published evaluation of the *Research premium* (Ecker, et al., 2017). The evaluation shows that the scheme is particularly supportive for continuous R&D in firms. The scheme was found to have a larger impact on R&D on the intensive margin, than on the extensive margin. The effects

[25] The corporate tax rate is at 25 percent i Austria.
[26] Earlier Austria also had a R&D allowance scheme which was repealed in 2011.
[27] The ceiling is € 1 million.
[28] Because of 2015/2016 tax reform, the R&D tax credit was increased from 10 to 12 percent. A further increase to 14 percent will be implemented from 2018.

were found to be particularly evident in enabling more investment in R&D infrastructure, acceptance of higher risk and accelerating implementation of projects. The evaluation further found some examples where R&D activities were relocated to Austria thanks to the scheme. The schemes ability to attract business R&D from other countries, where especially the case for countries that did not have R&D tax incentives (e.g. Germany).

Overall, the evaluation found that the scheme gives firms greater flexibility, but it does not stimulate expansion of R&D in firms with low or no R&D activities. For such firms, direct subsidies seem to be more effective. The firms studied in the evaluation reported that between 2010 and 2015 around 14,300 additional highly qualified employees were employed. The beneficiaries' satisfaction in terms of the scheme's design was found to be relatively high.

Because the scheme has become very generous, Ecker et al. (2017) also looks at the potential for misuse. In Austria every project is controlled by tax auditors in detail. Ecker et al. (2017) finds that these audits are often troublesome, especially when the scheme is applied for more advanced R&D (e.g. for prototyping). They further argue that the Frascati Manual is not always the best reference to give a clear guideline for distinctive features of R&D the scheme can be applied for.

Ecker et al. (2017) conclude that the potential for misuse is low as the tax audits are conducted very strictly. The one issue they highlight is the control of the deduction of direct funding for R&D when calculating the amount to be claimed. As with SkatteFUNN, aid received from other R&D enhancing measures should be deducted from the claim. Here, more transparency is asked for.

The UK incentivises R&D through a tax allowance

Investment in R&D as a proportion of GDP in the United Kingdom is below that of most other advanced countries. As a measure to improve UK's international position and productivity, a volume-based R&D tax allowance scheme for SMEs was introduced in 2000.[29] The scheme was extended to large firms in 2002 (Straathof, et al., 2014). In 2013 a refundable tax credit for large firms was introduced (Guceri & Liu, 2017).

In 2016, tax incentives accounted for 57 percent of total public support for R&D in the private sector (Appelt, Bejgar, Criscuolo, & Galindo-Rueda, 2016). This is equivalent to 0.13 percent of GDP. Total support for R&D in the private sector amounts to 0.23 percent of GDP. The current R&D tax scheme is permanent, relatively simple, and involves low administrative costs.

The R&D incentive is separated into one scheme for SMEs (*Corporate Tax Credit for R&D*) and one for large firms (*R&D Expenditure Credit Scheme*), offering more generous rates for the former group (Appelt, Bejgar, Criscuolo, & Galindo-Rueda, 2016). As with SkatteFUNN, both schemes are volume-based, and loss-making firms can receive a refund, regardless of size. In addition, the schemes offer an infinite carry-over opportunity.

Through the *Corporate Tax Credit for R&D*, SMEs can claim a 130 percent allowance rate, implying that for every £1 spent on R&D, the firm can deduct

[29] Prior to the introduction of R&D tax relief, only capital investment for "scientific research" was treated favorably by the tax system. The Scientific Research Allowance (SRA) allowed a hundred percent depreciation in the year of investment.

£1.3 from its pre-tax corporate income. The maximum amount that a R&D project can receive is € 7.5 million.

For large firms, the *R&D Expenditure Credit Scheme* (RDEC) was introduced in 2013. The scheme offers an 11 percent credit on the amount of firm's R&D expenses, set against corporation tax liabilities, meaning that it is less generous than the SME scheme (HM Revenue & Customs, 2017).

The tax incentives' impact in the UK

Although the UK's spending on R&D as a share of GDP is relatively low and stable, the popularity of the R&D tax incentive schemes has been increasing, especially during the financial crisis when the schemes became more generous.

Bond and Guceri (2012) measured the effect of the introduction of R&D tax credits on users' cost of capital for R&D investment for large firms, and specifically on the R&D intensity in manufacturing. They found that although the share of business expenditure on R&D (BERD) has been relatively stable, there has been a significant increase in R&D expenditure in the manufacturing sector. Using a difference-in-difference framework, Guceri (2013) found an increase in R&D expenditure of 18 percent in the group who used the tax incentive, relative to those who did not.

An evaluation carried by HM Revenue and Customs (HMRC) (2010) for the period between 2000 and 2007 and another study that analysed R&D effects in Northern Ireland between 1998 and 2003 by Harris et al. (2009) concluded that the R&D tax reliefs have had a positive impact on R&D expenditure. However, Harris et al. (2009) found that the productivity of firms in Northern Ireland could only be increased with very generous benefits. As noted by Harris et al. (2009), these effects can be lower in practice due to a relatively inelastic labour supply curve in the region.

A survey conducted by HMRC among firms undertaking R&D activities showed that firms believed R&D tax incentives enhanced their spending on R&D. However, in large firms R&D activities appeared not to be sensitive to R&D tax incentives, as their R&D investments are determined by long-term strategic plans. Nevertheless, in the presence of a tax allowance, firms were more inclined to invest in more risky projects.

Dechezleprêtre, Einiö, Martin, Nguyen and Van Reenen (2016) utilised firm-level data for SMEs and the regression discontinuity design to assess the impact of tax incentives on R&D and innovation. They concluded that the R&D tax incentives do have a significant positive effect on R&D expenditure and on patenting. The elasticity of R&D with respect to changes in costs was estimated to around 2.6. The increase in R&D was estimated to 1.7 times the forgone in tax revenue. The largest impact was found in smaller firms and should not be generalised across the entire population.

Guceri and Liu (2017) also found evidence that for every pound forgone in corporation tax income the additional R&D expenditure was larger than one, but slightly lower than in Dechezleprêtre et. al. (2016), namly 1.3 pounds in additional R&D per forgone pound. Dechezleprêtre et. al. (2016) also estimated that the aggregate business expenditure on R&D had increased by 10 percent between 2006 and 2011 due to the tax incentive. This implies that the relatively stable ratio of BERD to GDP, possibly would have been much lower in the absence of the scheme.

4 Input additionality of SkatteFUNN

At this chapter we apply two different approaches to estimate input additionality of SkatteFUNN. First approach is similar to the one used in the previous evaluation. It confirms that only firms with R&D expenditures under the project cost cap are stimulated to increase their R&D efforts. The second approach is more general and study how different changes in the scheme have affected firms' R&D behaviour. This approach shows that SkatteFUNN have high input additionality, but effects vary a lot depending on the type of change and the type of user-generation. For all generations input additionality is strongest in the start of use of SkatteFUNN and is declining thereafter until recent policy changes with significant increase of project cost cap in 2014-2015.

Implying reduction in the R&D costs, SkatteFUNN is intended to increase firm's R&D investments. That can happen either in the form of initiation of new R&D projects that otherwise would not have been initiated for firms that are doing R&D projects from before (at intensive margin) or in the form of stimulating new firms to start doing R&D (at extensive margin). This part of the evaluation assesses input additionality of SkatteFUNN, i.e. the SkatteFUNN effects on R&D expenditures at both margins.

There is a vast amount of evaluations pointing at positive impacts of R&D tax deduction schemes. The last full-scale evaluation of SkatteFUNN, conducted by Statistics Norway (Cappelen et al. 2008), concluded that the scheme overall worked as intended. The evaluation found that SkatteFUNN had contributed to more R&D, i.e. for every lost kroner in tax revenues Norwegian firms invested about 2 extra kroner in R&D. This is so called "bang-for-the-buck" (BFTB) measure.[30] The later evaluation of SkatteFUNN together with other R&D and innovation supporting programs (Cappelen, Fjærli and Iancu et al. 2015) did not focus on input additionality. Recently Freitas et al. (2017), who study additionality effects of SkatteFUNN compared to tax deduction schemes in France and Italy in 2004-2008, have also found positive input additionality of SkatteFUNN. However, reporting variation of effects across different industrial sectors, they do not report any BFTB measure.

The result found in the previous evaluation of SkatteFUNN seems to be high compared with other results in the literature. Of cause, the magnitude of the BFTB depends on the way it is calculated and on the type of R&D tax incentive (that makes it difficult to compare different evaluations).[31] However, the most common result in recent studies is BFTB lower than one (CPB, 2014). For example, the summary table in Straathof et al. (2014, p. 33) documents 10 estimated values for the BFTB for a range of countries and time periods. Of these 10 values, four are equal to 1 or larger, and the remaining six are positive but smaller than 1. Similar results are further confirmed by Becker (2015).

To answer to what degree SkatteFUNN has contributed to increase firm's R&D investments we must perform a counterfactual analysis. That is, we need to compare actual R&D expenditures with the investments that would have been realised in the absence of the scheme.

This is not a trivial exercise. Given that assignment to SkatteFUNN is not random, but a voluntary decision,[32] a direct comparison of policy-users and non-users will give a biased result. Firms who decide to

[30] This terminology is commonly used in the European policy debate to express the effect of R&D incentive policies in terms of additional R&D as a fraction of the forgone tax income for the government. A BFTB value of 1 would imply that for every euro of forgone tax income, an additional euro of R&D is undertaken by the firm. BFTB lower (higher) than 1 indicates that less (more) extra R&D is generated by the policy than forgone tax income.

[31] For incremental tax incentives it is by construction greater than 1,

[32] Every firm can potentially apply for SkatteFUNN.

use the scheme will likely make their decision because of certain factors that are not shared with firms that do not use the scheme. Some of these factors we can observe and account for, and some of them obviously not. Then an observed increase in R&D for the users of SkatteFUNN may be the result of these specific factors, rather than of the policy itself.

A range of quasi-experimental methods are developed to account for the self-selection of the policy-users and endogeneity of the policy.

Hægeland and Møen (2007) evaluated the input additionality in SkatteFUNN for a three-year period after the introduction of the scheme in 2002 and used a version of "discontinuity approach". Their main idea was to compare firms whose previous R&D expenditures prior to the introduction of SkatteFUNN were under the cap, with firms whose previous R&D expenditures were over the cap. Their findings suggest that the Norwegian R&D tax credit scheme had stimulated firms to increase their R&D expenditures. Further, they find that the estimated effect is largely driven by firms that in some years prior to SkatteFUNN has reported zero R&D, which confirms that the schemes' additionality is highest among firms with no prior R&D experience and in line with the firms' self-assessed additionality.

Our first approach to assess the scheme's input additionality follows Hægeland and Møen (2007), i.e. we use a "discontinuity approach", but instead of looking at introduction of the scheme, we evaluate effect of *an increase in the limit* of tax-deductible R&D expenditures in 2009.[33] This approach gives us similar results (however, of the lower magnitude) confirming that only firms with R&D expenditures under the cap that are stimulated to do more R&D.

Then we move to another approach, i.e. the generalised diff-in-diff method, to study additionality effects variation across different SkatteFUNN-user generations under different policy regimes. This approach follows the one applied in Mohnen et al. (2017) who have evaluated an innovation box tax policy instrument in the Netherlands.

The main advantage of this method is that it allows to consider any change in the organisation of the policy implying that we can use the whole period available for evaluation. Our main contribution compared to Mohnen et al. (2017) is that we combine the explored by them generalised diff-in-diff method with matching procedure. This procedure allows us to pick control-firms among non-users of SkatteFUNN that are as similar as possible to SkatteFUNN-users (given their observable characteristics). In addition to overall BFTB measure for SkatteFUNN, we calculate this measure both for each user-generation and each policy regime.

This approach confirms a positive and strongly significant input additionality of SkatteFUNN. The overall BFTB measure in the main model is equal to 2.07.[34] However, it varies a lot across user-generations and policy-regimes. Input additionality is strongest among two first generations of the SkatteFUNN-users (who started to use SkatteFUNN in 2002-2003 and 2004-2006) and equal to 2.55 and 2.42 correspondently. The weakest additionality is estimated for user-generation that started to use SkatteFUNN in 2007-2008 (when the limit for hourly costs was implemented into the scheme) and is

[33] The limit of tax-deductible R&D expenditures was also increased in 2014 and 2015, i.e. at the end of the time-period for this evaluation. However, given that we need to have observations before and after any change, we could not conduct such an analysis for the recent changes and limit our analysis for the period 2003-2013.

[34] This result is robust to the matching procedure and different model specifications wrt. choice of explanatory variables.

equal to 1.06. This user-generation is also the only generation that did not show any additional R&D expenditures during period 2009-2013.

For all generations input additionality is strongest in the start of use of SkatteFUNN and is declining thereafter until recent policy changes in 2014-2015. Under this policy regime when the limit of tax-deductible R&D expenditures was significantly increased, input additionality also increased for almost all user-generations. This development gives us a "smile"-shape in the graphs for the changes of SkatteFUNN effects over time. The same yields probability to start to do R&D, i.e. this probability was highest after SkatteFUNN introduction, declining after that and increasing at the end of the evaluation period. However, this positive effect is not permanent, so the "smile"-shape will probably change after some years.

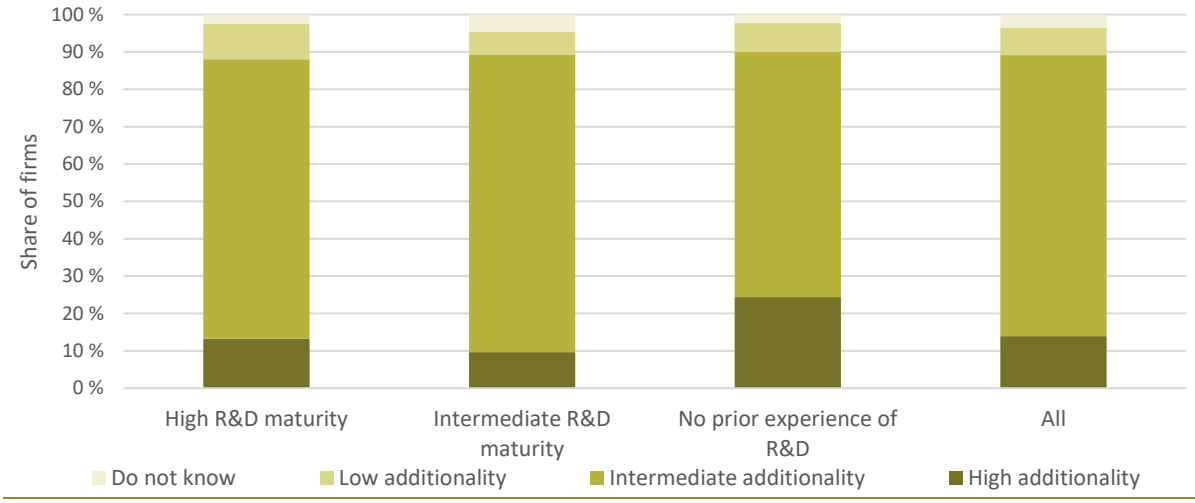
4.1 Self-reported input additionality

Our survey to users of SkatteFUNN indicates that most projects would have been conducted independent of the tax credit, but with a delay or in a smaller scale. That is, based on our survey, the scheme does not seem to have very high input additionality. This result is quite similar to the one from the survey conducted in the previous evaluation.

Firms were asked what would have happened if their project had not been co-funded through SkatteFUNN. Projects that would have been conducted in the same way without SkatteFUNN support are considered to have low additionality. Projects that would have been reduced in some of the directions (conducted on a lower scale, without external R&D partner or postponed) are considered to have intermediate additionality. Lastly, projects that would not have been conducted without SkatteFUNN support are considered to have high additionality.

Figure 4.1 illustrates how R&D maturity affects additionality. We find that firms with no prior R&D experience primarily stated that their project would not have been conducted without SkatteFUNN support (24percent, compared to 14percent for all projects). Firms that have only had one project also to a greater extent stated that their project would not have been conducted without SkatteFUNN support. Firms with 50 or more employees claim the highest additionality (19 percent high additionality, compared to 13 percent of micro-enterprises). Among projects that were initiated by a partner (another firm or an R&D institution), or as a result of a previous project, additionality was also high (20percent and 30percent had reported high additionality, respectively). However, our experience tells that this kind question tends to include a certain element of tactical considerations among respondents, i.e. some of them respond what they believe will increase the chances of a favoured measure being maintained (and vice versa). As we shall see later in this chapter, SkatteFUNN is an appreciated measure, so the survey results probably overestimate the level of additionality to some extent.

Figure 4.1 Self-assessed additionality of latest SkatteFUNN project. N=590.



Source: Technopolis web survey.

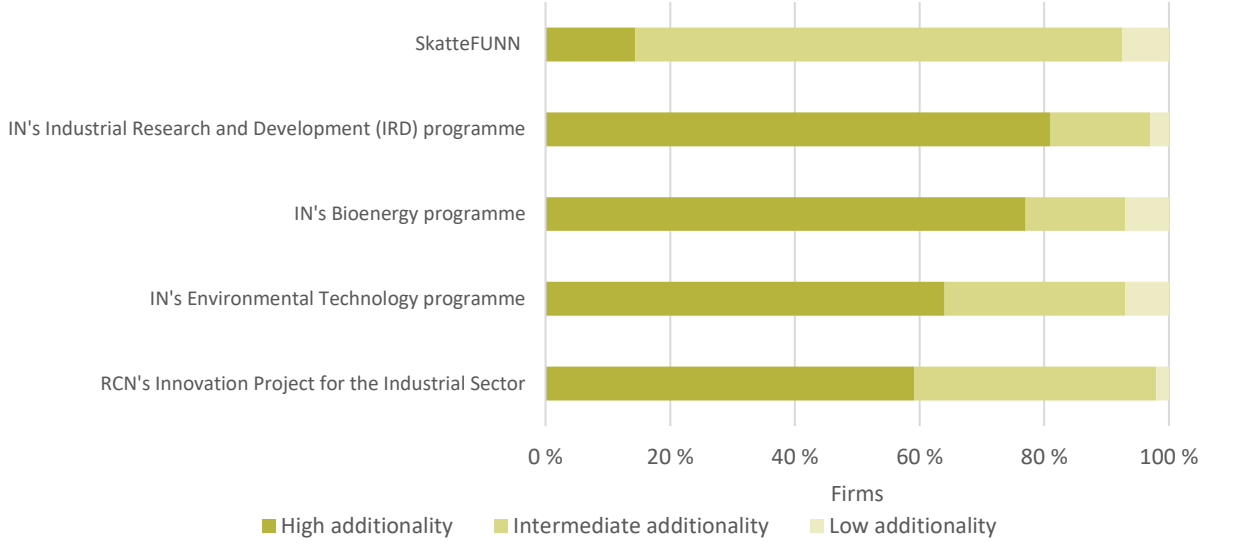
Although questions of similar nature have been asked in previous studies of SkatteFUNN, any direct comparison should be made with caution, as the specific formulation of a survey question can influence results. With this caveat in mind, we note that the result in this survey echoes the findings of both the previous evaluation of SkatteFUNN and RCN's annual user survey.[35] With same type of caveat in mind, we can compare additionality across different forms of public funding measures for industrially relevant R&D and innovation projects, see Figure 4.2. From this comparison we can conclude that SkatteFUNN projects are quite different in terms of generating projects that otherwise would not have been realised. In terms of share of projects with high additionality, the SkatteFUNN scheme lies well behind programmes and instruments of both IN and RCN.

This result is first of all connected to the volume of support, which is considerably lower for SkatteFUNN than for most other public supporting programs, and to the level of self-funding. That implies that SkatteFUNN plays a role of facilitator rather than initiator of an R&D project. It is probably also linked to the fact that SkatteFUNN projects are highly strategically important for firms and would be conducted regardless of tax deduction. Another possible reason is that SkatteFUNN is a rights-based measure (support is granted as long as basic eligibility criteria are fulfilled), whereas the other measures are competitive. This is further indicated by a recent study that found that "Firms seem to take SkatteFUNN support for granted, and it is not perceived as R&D support in the same sense as a [regular RCN] grant".[36]

[35] Foyn, F. and Arild Kjesbu, K., "Brukernes vurdering av SkatteFUNN-ordningen, Delrapport i evalueringen av SkatteFUNN-ordningen", Statistics Norway, 2006; "Undersøkelse om SkatteFUNN 2017", RCN, 2017.

[36] Åström, T. et al., "Case study analysis of a selection of projects in the User-driven research-based innovation (BIA) programme", RCN, 2017.

Figure 4.2 Self-valued additionality of industrially relevant R&D funding measures.



Source: Bergem, B.G. and Bremnes, H., "Resultatmåling av brukerstyrt forskning" (first bar from the bottom), 2014 (second, third and fourth bar); IN's Customer effect study 2016; Technopolis web survey (first bar from the top).

If we consider intermediate additionality, then SkatteFUNN is on par with the other support measures. Many interviewees describe that SkatteFUNN support is not vital for conduction of a project, but it determines the ambition level and allows the firm to take higher risks, which ultimately can increase the benefits of the project.

4.2 Data on R&D expenditures

The main challenge for the evaluation of R&D public support in most countries is a limited availability of data on R&D activities with Norway being no exception. While a detailed firm information is available from register data and yield almost all Norwegian firms,[37] information on R&D expenditures is primary available from R&D survey that cover only a small part of firms. The sample for the survey is selected using a stratified method for firms with 10–50 employees, whereas all firms with more than 50 employees are included. A survey among firms with less than 10 employees is conducted every other year after 2006. The number of firms in a survey varies between 4 and 6 thousand firms.

There are 34,466 firm-year observations in the SkatteFUNN database in 2002-2015. Of these, more than half are firms with less than 10 employees. Thus, most recipients of an R&D tax credit are not included in the annual R&D surveys. Only 10,292 (30 percent) are present in R&D surveys in the period 2002-2015 (cf. Table 4.1).

The Research Council of Norway collects information on firms' R&D expenditures three years prior to applying for R&D tax credit as part of the SkatteFUNN application, in addition to the budgeted R&D costs for each project. If we make use of these data,

[37] The number of firms in our dataset increases from about 130,000 in 1999 to about 210,000 in 2015. Observations with missing information on some key variables are excluded from the analysis.

we obtain additional information on R&D expenditures for almost all observations included in the SkatteFUNN database but not in the R&D surveys.

Table 4.1
Firm-year observations by data source and number of employees. 2002-2015

Obs. in SkatteFUNN database		Yes	
Obs. in R&D survey	Yes	No	Yes
No or missing employees	66	2,534	1
1-4	497	10,113	47
5-9	5,993	5,319	546
10-19	15,671	3,427	2,147
20-49	19,332	2,305	3,085
50-149	17,692	368	2,895
150+	9,058	108	1,581
Total	68,309	24,174	10,292

The quality check of these data with R&D expenditures reported in R&D survey showed that the larger the firm is, the more accurate information the "historical" R&D expenditures in the SkatteFUNN applications is. Again, we cannot check the accuracy of these data for the smallest firms, since they are not included in the survey. However, we prefer to use this historical information in order to keep most SkatteFUNN firms in the analysis. Moreover, this information is mainly used for the controlling for the previous R&D experience and, hence, the accuracy of amount is not very crucial.

In addition, we have information on other types of R&D support from our own database on public support for all Norwegian firms. That database comprises among others information on grants received from Research council of Norway, EU-programs and regional research funds and innovation support from Innovation Norway. We calculate then R&D expenditures by multiplying annual grants by two (assuming that R&D grants covers about 50 percent of the project costs).

Finally, we use information from each R&D survey on the budgeted R&D expenditures for the next year. We construct then the extended measure of R&D expenditures giving highest priority to the information on ongoing R&D from R&D survey, then to information from SkatteFUNN applications, then from our database on public R&D support and finally, to the budgeted R&D expenditures from R&D survey. This measure comprises the total R&D expenditures of the firm.

As a result, we have almost doubled number of observations with information on R&D expenditures (cf. Table 4.2). Not surprisingly, that yields mostly small firms with less than 10 employees.

Table 4.2
Firm-year observations by R&D information and number of employees. 2002-2015

	R&D survey		Extended data	
	R&D=0	R&D>0s	R&D=0	R&D>0s
No or missing	58	8	3,463	4,690
1-4	398	99	5,630	16,575
5-9	4,881	1,112	7,454	10,161
10-19	11,856	3,815	13,774	10,573
20-49	14,016	5,316	15,261	11,064
50-149	11,370	6,322	10,913	8,767
150+	4,959	4,099	4,507	5,390
Total	47,538	20,771	61,002	67,220

4.3 Estimation of input additionality by discontinuity approach

At this part of the analysis we follow Hægeland and Møen (2007) and use "discontinuity approach" to evaluate effect of an increase in the project cost cap in 2009. This approach gives us similar results (however, of the lower magnitude) confirming that only firms with R&D expenditures under the cap that are stimulated to do more R&D. The firms are also stimulated to continue doing R&D. However, we do not find that the 2009-change encourage more firms to start with R&D, i.e. probability to start R&D after change is not significantly different from the probability before the change.

4.3.1 Exploiting the discontinuity in the scheme

At the time the scheme was implemented the R&D tax credit was limited to investments up to NOK 4 million in intramural R&D or NOK 8 million in total R&D (cf. Chapter 2.5). Firms that would invest above the cap before the scheme was implemented would receive a subsidy with the implementation, but increasing their R&D expenditures would not increase their subsidy as they were already above the maximum possible amount. Thus, they did not receive any subsidies on their marginal investments. Firms that would invest less than the cap in absence of the scheme would, however, have an incentive to increase their R&D expenditures as it would increase their subsidy (Hægeland & Møen, 2007).

In 2009 the limit for R&D tax credit was increased to NOK 5.5 million in intramural R&D and NOK 11 million in total R&D. Thus, firms with positive R&D expenditures close to the old cap (NOK 4 million) got further incentives to increase their R&D expenditures, as they could increase their R&D expenditures and still receive subsidies on their marginal investments.

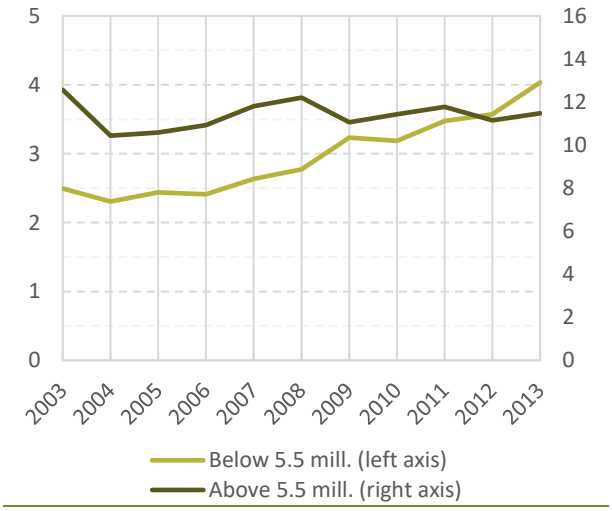
Exploiting the discontinuity in the scheme means that we compare firms with R&D expenditures below the cap with firms with investments above, and assume that the difference in R&D growth between the two groups is because one of the groups receive a tax credit for their marginal R&D expenditures. When using a "discontinuity approach" to evaluate effects, one usually tries to secure comparability of the two groups by narrowing the sample down to firms right above and right below the point of discontinuity or cap in the scheme (Hægeland & Møen, 2007).

The abovementioned approach requires that we determine which firms belong to which group. We restrict our sample to firms that report positive R&D expenditures prior to the change in the cap and that are never observed with investments above NOK 40 million in a single year.[38] Thus, all firms in the sample are R&D performers, and the largest R&D performers are excluded. Further, we split the sample in two groups and compare firms with average R&D expenditures above and below NOK 5.5 million prior to the change in the cap.

A first glance at the development in R&D expenditures for the two groups, indicate that an increase in the limit for tax deductible intramural R&D encouraged firms that used to invest less than NOK 5.5 million in R&D to increase their investments (cf. Figure 4.3).

Figure 4.3

Mean real intramural R&D for firms with and without a tax subsidy on the margin.[1] NOK million. 2003-2013



1) Only firms with positive R&D some year prior to the change in the cap and that received a tax credit in 2010 are included

[38] Hægeland and Møen (2007) include firms that are observed with positive investments at least one year prior to the introduction to SkatteFUNN. That is, the allow firms to have zero R&D in some years.

Firms that used to invest less than NOK 5.5 million in R&D before the increase in the cap in 2009 had on average 17 percentage points higher growth rate from 2008 to 2010, compared to firms that invested more than NOK 5.5 million in R&D in the same period (cf. Table 4.3). A two sample mean comparison t-test with unequal variance gives a p-value close to zero. Thus, the difference between the two groups is statistically significant and suggest that the tax credit scheme stimulates to additional R&D. However, this does not answer whether the observed difference is due to SkatteFUNN or other possible changes that affect the two groups differently.

4.3.2 Estimation strategy and sample construction

SkatteFUNN was made available to all Norwegian firms from 2003. As described in Chapter 2.5 there has been made several changes in the scheme in the years after that, e.g. increases in the tax-deductible amount in 2009 and every year since 2014. In this part of the evaluation we want to assess the effect of the change of project cost cap made in 2009, thus we have restricted the data to the period 2003-2013.

For firms with R&D investment below the limit for tax deduction it is reason to believe that aggregating reported R&D expenditures per firm would serve as a good estimate of the firm's R&D expenditures, assuming they apply for tax credit if they are R&D performers. However, for firms above the cap there is no reason to apply for tax credit after exceeding the limit. It seems that this is the case when looking at applicants' budgeted R&D expenditures. For the period 2003-2013 there's a concentration of aggregated investments per firm around NOK 4 and 5.5 million in intramural R&D (cf. Figure 4.4).

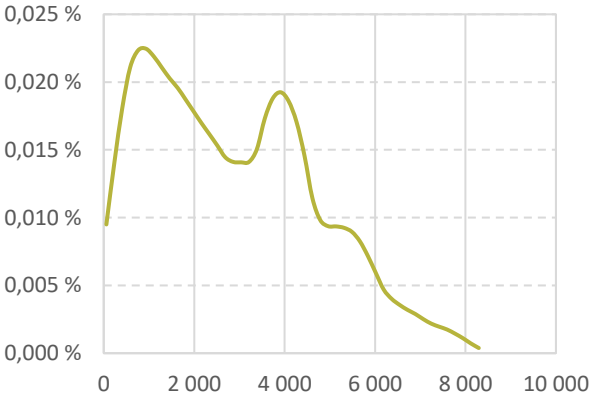
Table 4.3
Growth[1] in real intramural R&D for firms with and without a tax subsidy on the margin[2]

Growth in real intramural R&D from 2008 to 2010	Average pre-2009 intramural R&D expenditures		
	< 5.5 mill.	> 5.5 mill.	Difference
10th percentile	-0.67	-0.84	-0.17
Median	0.04	-0.07	0.11
90th percentile	0.81	0.47	0.34
Mean[3]	0.07	-0.10	0.17
Std. Err.	0.06	0.04	
Average pre-2009 intramural R&D	2 816 400	11 263 400	
N	212	86	

1) $(R\&D_{2010} - R\&D_{2008})/(0.5 \times R\&D_{2010} + 0.5 \times R\&D_{2008})$
2) Only firms with positive R&D some year prior to the change in the cap and that received a tax credit in 2010 are included
3) The difference between the two means are significant at the 1 percent level

Among firms included in the R&D surveys, 30 percent of the observations are reported positive R&D (total R&D expenditures greater than zero). The share of reported R&D expenditures greater than zero increases with firm size (cf. Figure 4.5).

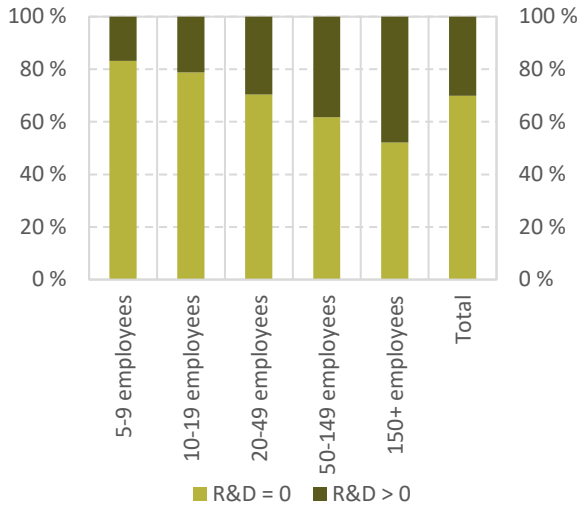
Figure 4.4
Estimated distribution of intramural R&D as reported in application to SkatteFUNN.[1] NOK 1 000. 2003-2013



1) Includes firms that report positive values below NOK 8 million in intramural R&D

Figure 4.5

Firm-year observations included in annual R&D surveys by reported R&D.[1] 2003-2008



1) Entire population of firms with more than 50 employees. Stratified sample for firms with 10-50 employees

For the entire period 2003-2013 there are 1,559 firm-year observations that report positive R&D in one or more years in the three-year period prior to applying for SkatteFUNN but report no R&D for the same years in the R&D surveys. Further, there are 449 firm-year observations with a positive R&D tax credit that report no R&D in the R&D surveys or for the three years prior to their application. This suggest that there is some uncertainty associated with the reported zeros.

When interpreting the econometric result below it is important to keep in mind that an essential share of SkatteFUNN recipients fall out of the analysis due to lacking data on R&D expenditures for firms with less than 10 employees. Thus, findings from the analysis based on data in the R&D surveys cannot necessarily be generalised to smaller firms, although many of the same incentives and mechanisms probably also apply for these (Cappelen et al., 2008).

One possible improvement of the data set is to expand the R&D information with applicants' reported R&D three years prior to applying for an R&D tax credit. As pointed out in Cappelen, et al. (2008), this only include firms that apply for R&D tax credit and not the entire population of enterprises. However, we also run our estimations on extended data below.

Like Hægeland and Møen (2007), we use a fixed effects regression approach to identify the causal effect of SkatteFUNN. Our sample consists of firms that are present in the R&D surveys and that have reported positive R&D every year prior to the increase in the cap for tax-deductible R&D expenditures. Firms reporting real R&D expenditures above NOK 40 million at some point are excluded, as well as observations with R&D intensity above 5, and observations with positive R&D tax credit but zero R&D in the R&D survey.

We have chosen to exclude firms that report positive R&D only in few years prior to the change in the scheme. We are interested in evaluating whether a more generous scheme affects firms' inclination to invest more in R&D (i.e. the effects of the scheme at the extensive margin). It seems reasonable to believe that whether the limit for tax-deductible R&D expenditures are 4 or 5.5 million is not crucial for firms with no or very little (and occasional) R&D expenditures in the years after the introduction of SkatteFUNN.

Given that our left-hand side variable is the natural log of R&D, we treat observations with zero R&D as zero; we set $\ln(R\&D)$ equal to zero for firms reporting zero R&D. This is equivalent to assuming that

firms reporting no formal R&D, invest NOK 1 000 in "informal" R&D.[39]

In the following we report our results from estimating the relationships specified in Hægeland and Møen (2007) on our sample. That is, we replicate their method to estimate the effect of the change in the cap in 2009.

4.3.3 Assessing short term additionality

First, we estimate a simple descriptive relationship where firms' R&D expenditures are explained by their sales, direct R&D subsidies, firm specific fixed effects and year dummies capturing common macroeconomic shocks and firms' specific temporary shocks. A change in the scheme should be picked up by the year dummies as firms should do more R&D than what they otherwise would do when there is a generous subsidy regime (Hægeland & Møen, 2007). This relationship is presented in equation 4.1.

$$\ln(R\&D_{it}) = \alpha + \gamma \ln(sales_{it}) + \chi \ln(subsidies_{it}) + \sum_{t=1}^{t=T} \delta_t D^{year\ t} + \eta_i + \epsilon_{it} \quad (4.1)$$

The estimated coefficients are reported in column (1) in Table 4.4. The year dummies represent differences in average R&D expenditures compared to 2003 (the base year). Except for a few years, the estimated coefficients indicate relatively little variation in average R&D expenditures and there is no clear shift in the level of R&D expenditures after the limit for tax-deductible expenditures was increased. Comparing only pre- and post-change years, as in column (2), suggest that firms do not invest significantly more in R&D after the cap was increased.

Second, we take into account that only firms investing less than NOK 5.5 million have an incentive to increase their R&D expenditures when the cap is increased. This is presented in equation 4.2; an expansion of equation 4.1 by interaction terms between the year dummies and a dummy for average pre-change R&D expenditures being below 5.5 million. Thus, $D^{BelowCap}$ is equal to one if a firm on average invested less than NOK 5.5 million in R&D in the period 2003-2008.[40]

$$\ln(R\&D_{it}) = \alpha + \gamma \ln(sales_{it}) + \chi \ln(subsidies_{it}) + \sum_{t=1}^{t=T} \delta_t D^{year\ t} + \sum_{t=1}^{t=T} \phi_t D^{year\ t} \times D^{BelowCap} + \eta_i + \epsilon_{it} \quad (4.2)$$

[39] All amounts are in NOK 1 000 in the data.

[40] See Hægeland and Møen (2007) for a discussion of which measure that best predict R&D expenditures in absence of SkatteFUNN.

Table 4.4

Short term additionality of SkatteFUNN

	(1)	(2)	(3)	(4)
ln(sales)	0.229***	0.208***	0.225***	0.228***
	(0.039)	(0.036)	(0.039)	(0.039)
ln(direct subsidies)	0.044***	0.037***	0.042***	0.043***
	(0.006)	(0.005)	(0.006)	(0.006)
2004	-0.242***		-0.157***	-0.239***
	(0.040)		(0.057)	(0.040)
2005	-0.113***		-0.001	-0.112***
	(0.040)		(0.057)	(0.040)
2006	-0.146***		0.047	-0.142***
	(0.047)		(0.078)	(0.047)
2007	-0.175***		-0.016	-0.172***
	(0.050)		(0.092)	(0.050)
2008	-0.162***		0.045	-0.156***
	(0.053)		(0.093)	(0.053)
2009	-0.119**		-0.037	-0.282***
	(0.051)		(0.091)	(0.062)
2010	-0.138***		-0.151*	-0.303***
	(0.052)		(0.086)	(0.062)
2011	-0.121**		-0.140	-0.286***
	(0.055)		(0.088)	(0.063)
2012	-0.157***		-0.236**	-0.321***
	(0.056)		(0.092)	(0.064)
2013	-0.083		-0.210**	-0.247***
	(0.058)		(0.089)	(0.064)
Post change period		0.025		
		(0.026)		
2004 x below 5.5 mill.			-0.108	
			(0.070)	
2005 x below 5.5 mill.			-0.152**	
			(0.075)	
2006 x below 5.5 mill.			-0.258***	
			(0.094)	
2007 x below 5.5 mill.			-0.214**	
			(0.105)	
2008 x below 5.5 mill.			-0.276**	
			(0.108)	
2009 x below 5.5 mill.			-0.108	
			(0.107)	
2010 x below 5.5 mill.			0.023	
			(0.105)	
2011 x below 5.5 mill.			0.034	
			(0.107)	
2012 x below 5.5 mill.			0.117	
			(0.110)	
2013 x below 5.5 mill.			0.184*	
			(0.109)	
Post change period x below 5.5 mill.				0.233***
				(0.053)
Constant	5.368***	5.474***	5.422***	5.382***
	(0.425)	(0.396)	(0.419)	(0.423)
Adj R-sq (within)	0.045	0.037	0.057	0.053
No. of obs.	5 877	5 877	5 877	5 877

Note: The dependent variable is ln(intramural R&D). All specifications include firm fixed effects

* p<0.10, ** p<0.05, *** p<0.01

Conditioning on sales, subsidies and firm specific levels of R&D expenditures, there seems to be no significant difference between firms above and below the cap in the years after the cap increased (cf. column (3) of Table 4.4).

If we only include an interaction between the post-change dummy and the dummy for average R&D being below NOK 5.5 million prior to the change, as in column (4), the coefficient is positive and significant at the 1 percent level. That is, firms that have their marginal cost of R&D expenditures reduced (firms below the cap) have larger R&D expenditures after the increase in the cap, compared to firms above the cap.[41]

The point estimate of 0.228 log points implies about 26 percent increase in R&D expenditures. This is a lower estimate than what Hægeland and Møen (2007) find when they evaluate effects of the introduction of SkatteFUNN; their corresponding estimate imply a little more than a doubling of R&D expenditures in the years after the introduction of the scheme. However, they find that the effect is largely driven by firms that in some years prior to SkatteFUNN have reported zero R&D. Thus, the high growth is typically happening from a very low level.

If we include firms that report zero R&D in some years prior to the increase in the cap the estimated coefficient becomes significantly negative, whereas including firms with positive R&D expenditures in at least one year prior to the change, and treating zero R&D as missing, gives similar results as the ones reported in Table 4.4. If we include all firms in the R&D survey, even those who never report positive R&D, the estimated coefficient becomes insignificantly different from zero.

Considering our relatively modest estimate, it is worth noting that the limit for tax deductible R&D expenditures was mainly increased in 2009 to dampen the effect of the global financial crisis (cf. Chapter 2.5). The number of firms receiving an R&D tax credit in this period (2008-2009) is the lowest number of recipients in the history of the scheme.

Third, we compare growth rates among firms that self-select into the tax credit scheme. That is, we estimate the specification in equation 4.3. The results are presented in Table 4.5.

$$\begin{aligned}\ln(R\&D_{it}) = \alpha &+ \gamma \ln(sales_{it}) \\ &+ \chi \ln(subsidies_{it}) \\ &+ \sum_{t=1}^{t=T} \delta_t D^{year\ t} \\ &+ \sum_{t=1}^{t=T} \phi_t D^{year\ t} \\ &\times D^{BelowCap} \\ &+ \theta SF + \beta SF \\ &\times D^{BelowCap} \eta_i + \epsilon_{it}\end{aligned} \tag{4.3}$$

The coefficient for the SkatteFUNN variable is insignificants in all specifications reported in Table 4.5. Thus, our results do not suggest that all firms do more R&D than what they otherwise would have done when they receive an R&D tax credit. However, for firms that used to invest in R&D below the limit of NOK 5.5 million, the coefficient is significantly positive, both for intramural R&D in monetary terms and on full-time equivalents. The estimated coefficient increases if we include firms that reports zero R&D for all or some years prior to the increase in the cap. If we include firms with zero R&D prior to 2009, the estimated coefficient on SkatteFUNN becomes significantly positive when intramural R&D is the dependent variable.

[41] The results in column (4) corresponds to the simple comparison of the two groups in Table 4.3.

Table 4.5

Short term additionality of SkatteFUNN, controlling for participation in SkatteFUNN

	(1)	(2)	(3)	(4)
	ln(intramural R&D)	ln(intramural R&D)	ln(R&D FTEs)	ln(R&D FTEs)
ln(sales)	0.213***	0.215***	0.257***	0.268***
	(0.038)	(0.038)	(0.065)	(0.066)
ln(direct subsidies)	0.039***	0.039***	0.024***	0.025***
	(0.006)	(0.006)	(0.006)	(0.006)
2004	-0.149***	-0.228***	9.244***	7.869***
	(0.057)	(0.039)	(0.068)	(0.093)
2005	0.005	-0.081**	9.277***	7.999***
	(0.057)	(0.040)	(0.073)	(0.086)
2006	0.050	-0.105**	9.352***	8.073***
	(0.078)	(0.046)	(0.080)	(0.085)
2007	-0.007	-0.132***	9.260***	8.029***
	(0.092)	(0.049)	(0.082)	(0.088)
2008	0.056	-0.111**	9.283***	7.993***
	(0.093)	(0.052)	(0.085)	(0.092)
2009	-0.029	-0.252***	9.256***	8.103***
	(0.091)	(0.061)	(0.083)	(0.091)
2010	-0.141	-0.273***	9.258***	8.071***
	(0.086)	(0.061)	(0.085)	(0.088)
2011	-0.130	-0.248***	9.249***	8.055***
	(0.087)	(0.062)	(0.090)	(0.090)
2012	-0.225**	-0.285***	9.156***	8.085***
	(0.091)	(0.063)	(0.095)	(0.093)
2013	-0.196**	-0.207***	9.118***	8.108***
	(0.089)	(0.063)	(0.107)	(0.098)
2004 x below 5.5 mill.	-0.105		-1.856***	
	(0.069)		(0.123)	
2005 x below 5.5 mill.	-0.118		-1.749***	
	(0.075)		(0.121)	
2006 x below 5.5 mill.	-0.212**		-1.749***	
	(0.093)		(0.124)	
2007 x below 5.5 mill.	-0.172*		-1.687***	
	(0.104)		(0.125)	
2008 x below 5.5 mill.	-0.230**		-1.768***	
	(0.108)		(0.130)	
2009 x below 5.5 mill.	-0.065		-1.524***	
	(0.106)		(0.120)	
2010 x below 5.5 mill.	0.064		-1.569***	
	(0.103)		(0.131)	
2011 x below 5.5 mill.	0.085		-1.576***	
	(0.106)		(0.136)	
2012 x below 5.5 mill.	0.165		-1.408***	
	(0.109)		(0.139)	
2013 x below 5.5 mill.	0.231**		-1.324***	
	(0.108)		(0.147)	
SkatteFUNN	0.059	0.064	-0.019	-0.008
	(0.056)	(0.057)	(0.041)	(0.049)
SkatteFUNN x below 5.5 mill.	0.233***	0.231***	0.279***	0.290***
	(0.066)	(0.066)	(0.077)	(0.081)
Post change period x below 5.5 mill.		0.246***		0.059
		(0.052)		(0.072)
Constant	5.390***	5.355***	-9.865***	-10.037***
	(0.407)	(0.410)	(0.706)	(0.718)
Adj R-sq (within)	0.086	0.082	0.823	0.816
No. of obs.	5 877	5 877	5 877	5 877

Note: The dependent variable is ln(intramural R&D) and ln(R&D FTEs). All specifications include firm fixed effects
* p<0.10, ** p<0.05, *** p<0.01

If the coefficient on SkatteFUNN captures a common self-selection effect, the coefficient for the interaction term can be considered as the effect of the tax credit itself (Hægeland & Møen, 2007).

Like in the previous evaluation (Hægeland & Møen, 2007), we find that firms that are used to invest less than the limit for tax-deductible R&D and that do not apply for SkatteFUNN, increase their R&D expenditures more than those above the cap that haven't applied for SkatteFUNN (interaction between post change period and below the cap in column (2) in Table 4.5). This effect is only significant when we measure R&D as intramural R&D.

4.3.4 Probability to start or continue R&D

In the analysis above, we only included firms that always reported positive R&D prior to the increase in the cap in 2009. We now want to study whether the increase in the cap had an effect on the probability to start doing R&D (i.e. effect of the scheme at the extensive margin). Again, following Hægeland and Møen (2007), the estimation of the probability to start doing R&D is done as a separate analysis, based on the argument that the decision to start doing R&D for the first time is different from deciding how much R&D to do.

Hægeland and Møen (2007) find that in the years 2003 and 2004, i.e. first two years after the introduction of SkatteFUNN, firms that did not do R&D two years earlier had 6-7 percentage point higher probability of starting to do R&D, compared to the years 1995-2001. Further, they find that this positive effect is not present in 2005 and their interpretation is that the pool of potential R&D performers among those that did not previously do R&D seems to be exhausted quickly after the scheme was introduced.

If the abovementioned interpretation holds, there is reason to believe that there is no any strong effect on the probability to start doing R&D of the increase in the cap in 2009. Further, if firms haven't already started doing R&D in the presence of a scheme offering tax credit on intramural R&D up to NOK 5.5 million and total R&D costs up to NOK 8 million, it seems unlikely that increasing the limits will affect much their propensity to start doing R&D.

Including firms that have never invested in R&D in the sample and estimating the probability to start doing R&D, given that the firm did not do R&D two years earlier, confirms our assumptions. We find no significant change in the probability to start doing R&D after the increase in the cap (cf. Table 4.6).

Table 4.6
Probability of starting or continuing R&D

	Intramural $R\&D_{t-2} = 0$	Intramural $R\&D_{t-2} > 0$
ln(sales)	0.023***	0.028**
	(0.006)	(0.011)
$ln(sales)_{t-2}$	-0.013**	-0.031***
	(0.006)	(0.011)
2010[1]	-0.005	0.043***
	(0.008)	(0.013)
2011[1]	-0.010	0.049***
	(0.008)	(0.013)
2012[1]	-0.003	0.053***
	(0.008)	(0.012)
2013[1]	0.014	0.075***
	(0.009)	(0.012)
Pseudo R-sq	0.007	0.008
No. of obs.	11 476	7 523

1) Marginal effect for discrete change of the dummy variable from 0 to 1. The years 2003-2009 are absorbed by the constant term and not reported
* p<0.10, ** p<0.05, *** p<0.01

Looking at the probability of continuing to do R&D, given that a firm did R&D two years ago, we find significantly positive effects that increases for each year in the period after the increase in the cap in 2009. Thus, the probability to continuing to do R&D increased after the limit for tax-deductible R&D expenditures increased, compared to the period prior to the increase.

4.3.5 Expanded R&D information

If we expand the data from the R&D surveys with information on firms' R&D expenditures from SkatteFUNN applications and information on R&D grants (cf. 4.2), we get similar results as the ones reported above.

However, if we include zeros from these additional sources, the number of observations in the sample decreases. Our explanation is following. If a firm is included in the R&D surveys for the period 2006-2008 and report positive R&D, but information on R&D is missing for the some of the years, the firm is included in our sample. However, if the firm report zero R&D in one of the years in the extended dataset, then it is excluded from the sample. Thus, if some of the missing observations are replaced by zero when we expand the data, the firm falls out of the sample, which explains the reduction in number of observations when we expand the data. The reduction is, however, moderate.

Hægeland and Møen (2007) stress the importance of reported zeros in their analysis and whether these are true zeros or not. Additional sources of information on firms' R&D activity suggest that some of the reported zeros are indeed zero and some are not.

4.3.6 Bang for the buck

In assessing the success of the scheme, we need to know how much additional R&D has been induced per krone spent on the scheme. That is, we want to estimate the so-called "bang for the buck" (BFTB).

For reference, a project that would not have been undertaken at all without the R&D tax credit will have a BFTB of $\frac{1}{0.20} = 5$ if an SME and $\frac{1}{0.18} = 5.56$ for other firms (based on the tax credit rates 20 and 18 per cent correspondently).

If not an SME. A project that would have been undertaken in full, without the tax credit will have a BFTB of zero. Typically, a BFTB of 1 or slightly more is considered acceptable (Hægeland & Møen, 2007).

We first want to estimate the BFTB based on data from the R&D survey. To do this we use our estimated change in R&D investments induced by a firm below the cap receiving an R&D tax credit. In equation 4.3, β is the estimated change in $\ln(R\&D)$ - all else equal. Thus, the expected value of the counter factual R&D investment in absence of a tax credit for a firm below the cap is:

$$\ln(R\&D_{it}^{without\ tax\ credit}) = \ln\left(R\&D_{it}^{with\ tax\ credit}\right) - \beta$$

Following Hægeland and Møen (2007), we calculate the counterfactual R&D investment for all firms in the sample below the cap and with an R&D tax credit and summarise the difference between this and each firm's observed R&D investments. Doing this we get additional R&D investments of NOK 1,539,800. Further, we summarise the R&D tax credit received by all firms in the sample, both firms above and below the cap and get NOK 1,645,800. The former divided by the latter gives an estimate for the BFTB for the firms in our sample of 0.94. That is, for each krone given in tax credit one gets less than one krone in additional R&D.

The estimated BFTB reported above is significantly lower than what Hægeland and Møen (2007) get with the same approach. However, our sample only include firms that always report positive R&D investments in the R&D surveys in the years prior to the increase in the cap. If we include firms that in some years prior to the change report zero R&D, the estimated BFTB is 4.4. Given this relatively large discrepancy, it is important to keep in mind that the estimates are proven to be sensitive to sample restrictions and model specifications. In addition, the

sample used is not representative for the true composition of firms participating in the scheme (Hægeland & Møen, 2007).

When the sample is restricted to firms that are included in the R&D surveys, and in addition have to report positive R&D every year they participate in the survey, our sample is restricted to large firms measured in number of employees. Average number of employees for firms in the sample is 115. Thus, the estimated BFTB of 0.94 must be seen as an estimate for relatively large R&D performers. We present estimates for a more representative sample of SkatteFUNN users below.

4.4 Estimation of input additionality by generalized difference-in-difference approach

At this part of the analysis we follow Mohnen et al. (2017) and use "generalized diff-in-diff" approach with matching to study additionality effects variation across different SkatteFUNN-user generations under different policy regimes. This approach confirms a positive and strongly significant input additionality of SkatteFUNN. The overall BFTB measure in the main model is equal to 2.07. However, it varies a lot across user-generations and policy-regimes. For all generations input additionality is strongest in the start of use of SkatteFUNN and is declining with time passed until recent policy changes in 2014-2015.

As described in Chapter 2.5 there has been made several changes in the scheme after its introduction in 2002. In the previous chapter we have exploited the effect of one change on the firms' R&D investment, i.e. of an increase in the limit of the tax-deductible amount in 2009. We move now to another approach that uses the generalised diff-in-diff method.

The main advantage of this method is that it allows to consider any change in the policy implying that we can use the whole period available for evaluation. We can study then how input additionality of SkatteFUNN varies under different policy regimes. Moreover, we can compose generations of SkatteFUNN-users and follow their R&D investment behaviour under different policy regimes.

The approach applied here follows the one used by Mohnen et al. (2017) who have evaluated the innovation box tax policy instrument in the Netherlands. The rules and conditions of this policy changed yearly during the evaluation period 2007-2013 making it difficult to isolate the effect of one change in the policy from another.[42] The case of SkatteFUNN is more stable, i.e. the changes in the scheme have happened with 2-3 years in between. That gives us a good chance not only to evaluate the input additionality of the whole scheme, but also to track on which changes in the policy were more effective with respect to changing the firms' R&D behaviour.

4.4.1 Introduction to the method

The difference-in-differences method is typically implemented in a situation with two periods, e.g. one with and one without the policy or one before the change and one after. The regression used in this case is following:

$$Y_{it} = b_0 + b_1 D^1 + b_2 S_i + b_3 D^1 S_i + \sum_j \beta^j X_{it}^j + \varepsilon_{it} \quad (1)$$

[42] Especially, in the situation when the effect of any specific change is assumed to yield more than 1 year.

Here, ***Y*** is the dependent variable by which we want to measure the effect of the policy (R&D expenditures in our case), and X^j is a range of control variables. ***D***[1] is a dummy-variable equal to 1 for period 1 (when the policy exists) and 0 for period 0 (when the policy does not exist and hence no firm uses the policy). ***S*** is an indicator for policy users (a dummy variable that equal to 1 if the firm has used SkatteFUNN in any year after introduction of the policy) and 0 for the control group of firms that have never used the policy.

The estimated parameter $\boldsymbol{b}_0$ measures then the average outcome (in terms of ***Y***) for the control group in period 0. $\boldsymbol{b}_0+\boldsymbol{b}_1$ is the average outcome for the control group in period 1. $\boldsymbol{b}_2$ is the difference between the control group and the policy users in period 0 (this difference already exists before the policy is implemented, and is therefore not a part of the effect of the policy). $\boldsymbol{b}_0+\boldsymbol{b}_2$ is the average outcome for users of the policy in period 0, while $\boldsymbol{b}_0+\boldsymbol{b}_1+\boldsymbol{b}_2+\boldsymbol{b}_3$ is the average outcome for these firms in period 1. The difference in outcome for policy users between period 0 and period 1 is therefore $\boldsymbol{b}_1+\boldsymbol{b}_3$. Of this, $\boldsymbol{b}_1$ is identical to the difference for the control group. Hence, $\boldsymbol{b}_3$, which is the difference-in-differences, measures the 'additionality' of the policy, which is the extra R&D performed as a result of the policy.

If SkatteFUNN have not changed after implementation, we could use the simple model. However, in our case when policy has changes several times, we need to apply a difference-in-differences method with more than one period. We then use the following specification where equation (1) is transformed to a multiple period case:[43]

$$
\begin{aligned}
& Y_{it} \\
& = \gamma^0 \\
& + \sum_{T \neq 0} \gamma^T G_i^T + \sum_T \tau^T D^T \\
& + \sum_{T_0} \sum_{T_1 \geq T_0} \alpha^{T_0 T_1} G_i^{T_0} D^{T_1} g_{it} + \sum_j \beta^j X_{it}^j \\
& + \varepsilon_{it}
\end{aligned}
\qquad (2)
$$

Here, ***T*** is a categorical variable that can be equal to 0, 1, 2, 3, etc. depending on the total number of periods. $\boldsymbol{G}^T$ is an indicator variable for generation of the users that start using the policy in period ***T>0*** (0 remains for the period without the policy). $\boldsymbol{D}^T$ is a dummy variable for time period ***T***, while g_{it} is a dummy variable that indicates whether firm ***i*** uses the policy in period ***t***. $\boldsymbol{T}_0$ represents the period just before the first use of the policy, and T_1 any other period after this.

The parameters γ, τ, α and β are to estimate. The γ parameters correct for differences between policy users and non-users that already existed before the introduction of the policy, to the extent that these differences are not reflected in the set of variables ***X***. As pointed by Mohnen et al. (2017) the usage of multiple γ parameters enables us to distinct between different categories of users, such as early and late adopters of the policy (non-users will have zero value for all ***G*** variables). In other words, we allow firms that begin using the policy immediately after it has been introduced differ from firms that start using the policy later (probably encouraged by the specific policy change).

The τ parameters correct for differences between policy regimes that took place between policy changes. Because, as discussed earlier, there were

[43] We follow here the model specification (2a) in Mohnen et al. (2017) that assumes a short-term effect of the policy use on R&D dependent variable, i.e. when the effect is limited to the time period in which the use of the policy occurs. Another specification used Mohnen et al. (2017) assumes that the firm will always have an effect as a result of a one-period use of the policy. While innovation box tax credit is applied to the output of possibly quite long R&D effort, SkatteFUNN tax credit yields R&D expenditures in the given year and the average project length is 2 years. Hence, we prefer to use here the former model specification.

several changes in the SkatteFUNN, it is important to account for these differences.

Finally, the α parameters measure the effect of the policy. Instead of just a single effect, we estimate one effect for each combination of user-generation (***G***) and period (*T*). For example, the parameter $\alpha^{1,3}$ would measure the effect of the policy in period 3 on firms from the first user generation (those who started to use the policy just after its introduction). A similar parameter (effect) is estimated then for every possible combination of period and generation.

4.4.2 SkatteFUNN policy regimes and user generations

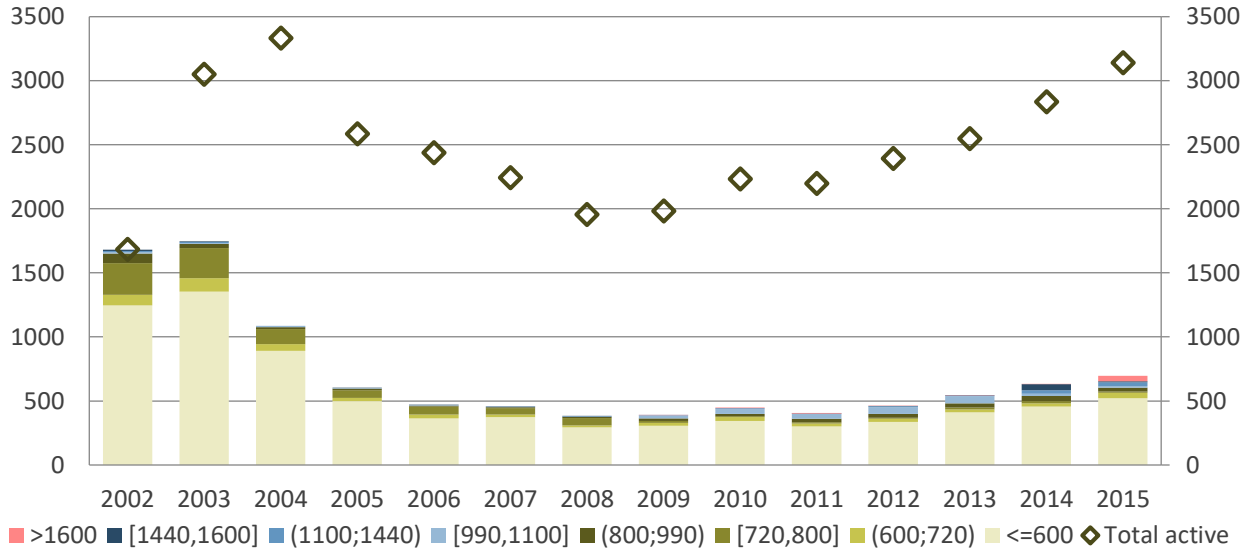
Before we move to estimation of the model (2) we need to define the policy regimes. The data for this evaluation are available for the period 1999-2015. SkatteFUNN was introduced in the Autumn 2002 for SMEs only, but already in 2003 it was expanded to all firms. We then define the first regime that comprises "early users" of the policy to be 2002-2003.

Figure 4.6 shows how many firms started to use SkatteFUNN each year after introduction. We observe that the scheme was most popular just after introduction. The interest was then declining until 2009 and increasing again after that. We can also see that the interest increased more among earlier users rather than among new users.

Further, we want to account for the changes in the project cost cap that took place in 2009, 2014 and 2015. The tax credit rate was unchanged during the whole period of SkatteFUNN existence (20 percent for SMEs and 18 percent for others).

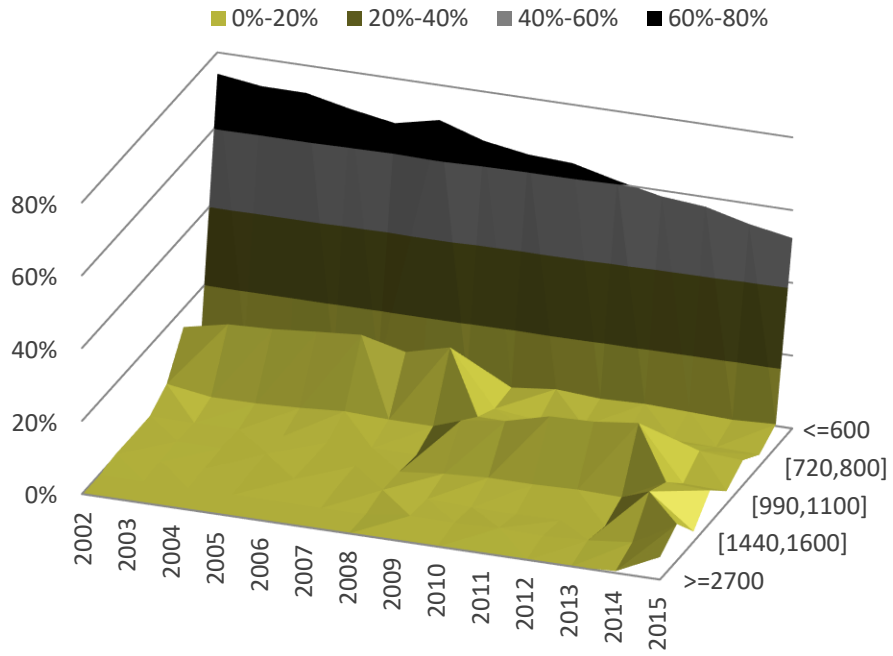
Figure 4.7 demonstrates the share of SkatteFUNN users by the size of received tax credit. We can observe that most of users have never reached the project cost cap (their share was about 80 percent in 2002 and felt to about 60 percent in 2015). It seems also that existing SkatteFUNN users who reached the project cost cap in the start moved further to the new level after extensions in 2009 and 2014-2015. Very few "new" users have so high R&D expenses that they could receive the maximum of tax credit (cf. Figure 4.6).

Figure 4.6 Number of new SkatteFUNN users by tax credit size and number of active users.



Source: Samfunnsøkonomisk analyse and Statistics Norway

Figure 4.7 Transition of SkatteFUNN users from one top to another after changes in 2009 and 2014-2015. Share of users by tax credit size.



Source: Samfunnsøkonomisk analyse and Statistics Norway

Finally, there were other changes in the rules in 2007 and 2011. The former change introduced additional caps on hourly wages and yearly hours for calculation of project costs. While new definitions of R&D and SMEs were applied from 2011. Both these changes could also affect firms' R&D behaviour and their willingness to apply for SkatteFUNN and start doing R&D.

As a result, we end up with six policy regimes and six SkatteFUNN-user generations correspondently; 2002-2003, 2004-2006, 2007-2008, 2009-2010, 2011-2013 and 2014-2015. The first one comprises early adopters of a new policy, the second cover the period before 2007-change, third before 2009-change, forth before 2011-change, firth before the changes in 2014-2015 that we grouped in the last, sixth, group.

4.4.3 Variables construction

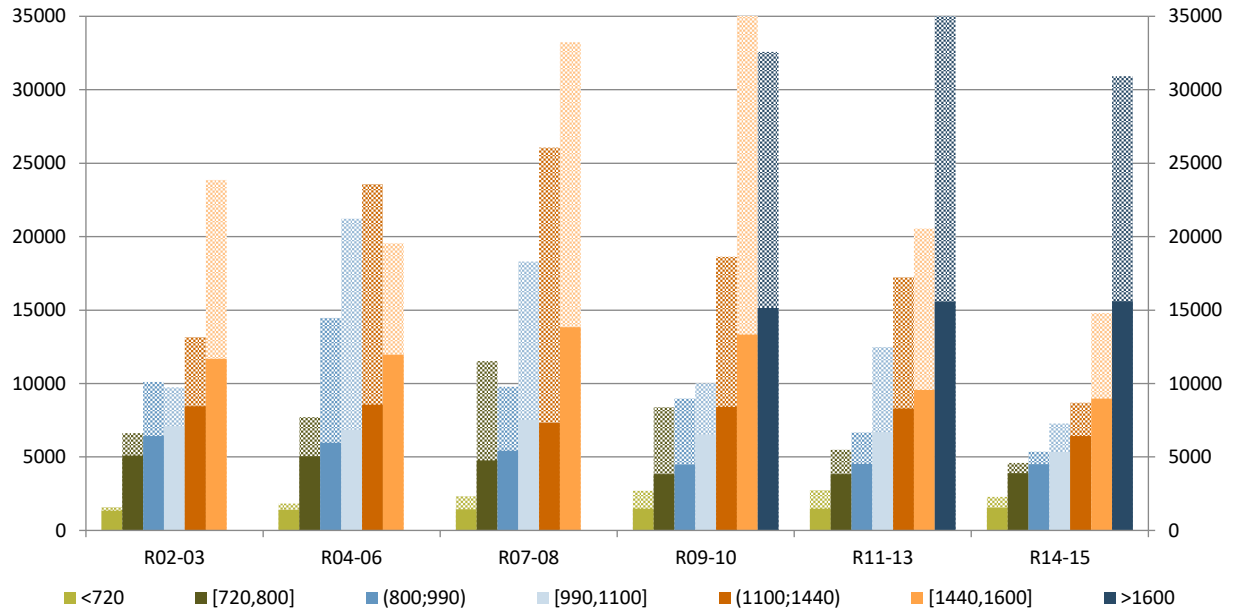
Dependent variable (*Y* in equation 2): total R&D expenditures (log)

As was pointed out in the subchapter 4.2, only 30 percent of observations on SkatteFUNN firms are present in R&D surveys in the period 2002-2015. We then utilize all available information on R&D from other sources. These sources are SkatteFUNN data from Tax authorities on R&D expenditures that are eligible for the tax credit, historical data on R&D expenditures in 3 years prior to SkatteFUNN application (data collected by Research Council of Norway), and data on R&D grants and other public support for R&D from our own database.

Figure 4.8 compares data on R&D expenditures reported to Tax authorities with the extended measure of R&D expenditures (cf. subchapter 4.2 for details of construction of this measure). We can observe

that SkatteFUNN firms tend to report to the Tax authorities only part of their R&D that is eligible for the tax credit and not the whole R&D activity. The higher received tax credit is, the larger this difference is. While Mohnen et al. (2017) use an R&D information from their WBSO/RDA tax credit scheme, observing such a large underreporting of R&D expenditures to the Norwegian Tax authorities, we prefer to use the extended R&D measure for the further analysis.

Figure 4.8 Average R&D expenditures by data source, tax credit size and SkatteFUNN-regimes. 1000 NOK. R&D data from Tax authorities compared with other data sources.



Source: Samfunnsøkonomisk analyse, Tax authorities and Statistics Norway

Control variables (*X* in equation 2)

Firm size: number of employees (log, log^2). Large firms tend to invest in R&D more often and more than small firms.

Liquidity constrain rate: current assets/short-term debt (log). Many studies have documented that a firm's ability to innovate is affected by the availability of own funds. We would thus expect constrained firms to be less involved in R&D activities and more active in searching R&D support.

Share of high-skilled employees: Share of man-hours worked by employees with upper secondary education. This variable is very often used in the R&D and innovation related analyses since firm need to have qualified personal to do R&D.

R&D support from other sources: direct subsidies (log). As shown in chapter 2.8 SkatteFUNN is the only source of R&D support for about 65 percent of SkatteFUNN users. However, the rest 35 percent of firms use other sources of public support. We then need to control for that.

Past R&D experience: dummy variable for positive R&D in at least one year during the previous 3-year period. There is a large persistency level in doing R&D, hence, firms with recent R&D experience will have higher probability of doing R&D than firms without such an experience. For new established firms (0-1 years old) this dummy is set to zero (if not observed positive R&D).

Other firm characteristics: firm location and industry dummies. These are included to account for regional and industry specific differences.

Time dummies: These are included to account for time-specific effects and macro shocks that are not covered by policy regimes dummies.

4.4.4 Estimation strategy: combination of diff-in-diff with matching

The last step we do before moving to estimation of equation (2) is the propensity score matching. We use this procedure to construct the control group of firms that is as much as possible comparable with SkatteFUNN firms (given observable characteristics).

We apply matching with stratification following the similar procedure as in Cappelen et al. (2015), where in addition to specification of cells based on the firms' industry, region and cohort, we include an indicator whether the firm have used additional public support or not.[44] In that case we match the SkatteFUNN firms to firms from the same industry and region, established at the same year and with corresponding indicator on use of other types of public support, but that have never participated in SkatteFUNN.

Our matching variables are measured at start-up, or at the first observation year (mainly 2000) for firms established before 2000, and include firm size measured by total assets and number of employees, share of employees with high education, financial liquidity rate defined as current assets divided by short-term debt and indicator for previous R&D experience (during last 3-year period). We use the STATA routine *psmatch2* with 1 to 5 nearest neighbour matching with trimming.[45]

The availability of latter variable restricted the entire population of firms remarkably, so we do the alternative matching without an indicator for R&D experience. The results of first matching (with controlling for R&D experience) are used as our main specification. While the results from the second matching (without controlling for R&D experience) are used as an alternative specification and for robustness check. In any case we control for the previous R&D experience when estimating diff-in-diff model (2).

As stressed by Blundell and Costa Dias (2009) and pointed by Cappelen et al. (2015), the matching variables must be determined before a unit potentially *can* be assigned to treatment (not just before it actually *is)*. This is a large problem when the time of treatment is not a fixed date, as in the case of tax credit use. However, most of SkatteFUNN users are matched in 2000, i.e. two years before SkatteFUNN introduction.

Table 4.7 reports firm characteristics for SkatteFUNN and control firms before and after matching procedure without controlling for the past R&D experience, while Table 4.8 reports firm characteristics before and after matching procedure with controlling for the previous R&D experience.

[44] This indicator comprises support from R&D support from Research council of Norway, regional research funds and through EU-programs, as well as through an innovation assignment from Innovation Norway.

[45] The option specification used is: *neighbor (5) common trim(10).*

We can observe that SkatteFUNN firms are larger (both measured by number of employees and total assets), they are more mature, have higher share of high-skilled employees, their financial liquidity is lower, and they more often use other types of support than not SkatteFUNN-firms. As was also demonstrated in subchapter 2.4, SkatteFUNN-users are overrepresented in such industries as ICT, technical services and manufacturing.

Table 4.7 shows also the number of firms before matching (the entire population) and after matching. The total population numbered 9,284 SkatteFUNN firms and 335,618 firms that have not used SkatteFUNN during 2002-2015. After matching without controlling for past R&D experience we end up with 5,241 SkatteFUNN firms (about 33 percent of the entire population of SkatteFUNN firms) and 19,822 control firms with the same regional and industrial distribution, with similar organizational age, financial liquidity rates and share of high-skilled employees in the start of their observational period. However, we failed to match successfully the firms by their size, i.e. SkatteFUNN firms are still significantly larger in terms of number of employees and slightly larger in terms of total assets.[46] However, the difference is much lower than between SkatteFUNN firms and other in the entire population.

If we do use the past R&D experience as an extra control variable under matching (cf. Table 4.8), we start with 7060 SkatteFUNN firms and 227,934 firms that have not used SkatteFUNN during 2002-2015. Not that high number of firms in the latter group are new established firms (by construction of past R&D experience variable), i.e. their average age is less than 1 year. After matching with controlling for past R&D experience we end up with 3,089 SkatteFUNN firms (about 56 percent of the entire population of SkatteFUNN firms) and 11,199 control firms that are not significantly different from matched SkatteFUNN firms (H0: that a set of means is equal between two groups is not rejected by Hotelling test, cf. F-test at the bottom of the table).

It is worth to note that in both cases we end up with smaller SkatteFUNN firms than firms in the entire population, since the largest firms are difficult to find a good match for. That is what we can call the "price" of this method usage, i.e. we get reliable results, but for the smaller sample of firms that is not necessary representative for the whole group of treated firms. Therefore, our estimation results by diff-in-diff method will not be applicable for the entire population of SkatteFUNN firms, but rather for the SMEs. In contrary, larger firms are overrepresented in the R&D survey that is the main data source in the analysis presented in the previous chapter and in chapter on output additionality. That means that we will be able to make some conclusions for this group of SkatteFUNN users too.

[46] We use STATA command pstest to test whether means for each separate variable significance of

Table 4.7 Firm characteristics before and after matching procedure. Population of all firms.

		Before matching				After matching		
Variables	SKF-firms	not SKF-firms	%bias		SKF-firms	not SKF-firms	%bias	
No. of employees	29.54	3.62	11.8	***	10.12	8.11	7.70	***
Total assets	80799	14830	6.6	***	18901	11845	3.80	*
Organisational age	5.10	3.89	12.6	***	5.87	5.96	-0.8	
Share of high-skilled	0.36	0.14	63.5	***	0.33	0.32	0.10	
Financial liqudity rate	31.70	68.09	-17.9	***	32.18	33.85	-1.00	
Dummies:								
Other types of support	0.27	0.004	84.2	***	0.04	0.04	0	
Bioeconomics	0.10	0.03	29.6	***	0.10	0.10	0	
Mining&quarrying	0.01	0.005	7.2	***	0.003	0.003	0	
Tech. manufacturing	0.11	0.01	41.1	***	0.11	0.11	0	
Other manufacturing	0.08	0.02	29.1	***	0.06	0.06	0	
Construction	0.04	0.12	-32.4	***	0.03	0.03	0	
Retail trade	0.11	0.19	-22.5	***	0.14	0.14	0	
Transport	0.02	0.04	-14.3	***	0.01	0.01	0	
Tourism	0.01	0.05	-23.8	***	0.01	0.01	0	
Media	0.05	0.01	20.3	***	0.04	0.04	0	
ICT	0.15	0.03	45.1	***	0.17	0.17	0	
Professional and scientific activities	0.11	0.34	-57.7	***	0.12	0.12	0	
Tech. services	0.12	0.04	32.1	***	0.12	0.12	0	
Business-oriented services	0.04	0.05	-4.1	***	0.04	0.04	0	
Education	0.01	0.01	-2.0	*	0.00	0.00	0	
Helth	0.01	0.03	-12.0	***	0.00	0.00	0	
Other service activities	0.04	0.03	4.4	***	0.03	0.03	0	
Capital region	0.27	0.30	-7.1	***	0.31	0.31	0	
East-Norway	0.19	0.23	-9.3	***	0.21	0.21	0	
Souht	0.17	0.15	6.0	***	0.16	0.16	0	
West	0.20	0.17	7.7	***	0.20	0.20	0	
Mid-Norway	0.10	0.07	10.1	***	0.07	0.07	0	
North	0.07	0.08	-3.6	***	0.06	0.06	0	
No. firms	9284	335618			5241	19822		
F-test		3215.38***				1.70**		

Table 4.8 Firm characteristics before and after matching procedure. Population of firms with information on

		Before match				After match		
	SKF-firms	not SKF-firms	%bias		SKF-firms	not SKF-firms	%bias	
No. of employees	21.98	2.64	36.1	***	10.71	10.07	2.2	
Total assets	77882	14261	5.8	***	14089	12304	2.9	
Organisational age	3.35	0.45	44.4	***	3.08	3.06	0.2	
Share of high-skilled	0.36	0.13	68.5	***	0.31	0.30	2.7	
Financial liqudity rate	36.62	81.42	-20.3	***	42.49	44.86	-1.2	
Dummies:								
Recent R&D experience^	0.15	0.002	58.0	***	0.04	0.03	9.4	***
Other types of support	0.30	0.004	90.2	***	0.02	0.02	0	
Bioeconomics	0.09	0.02	28.6	***	0.09	0.09	0	
Mining&quarrying	0.01	0.00	7.6	***	0.00	0.00	0	
Tech. manufacturing	0.11	0.01	43.1	***	0.10	0.10	0	
Other manufacturing	0.08	0.01	32.4	***	0.06	0.06	0	
Construction	0.03	0.13	-38.9	***	0.02	0.02	0	
Retail trade	0.09	0.16	-20.3	***	0.12	0.12	0	
Transport	0.01	0.03	-14.6	***	0.00	0.00	0	
Tourism	0.01	0.05	-25.6	***	0.00	0.00	0	
Media	0.05	0.01	21.7	***	0.04	0.04	0	
ICT	0.18	0.03	49.4	***	0.23	0.23	0	
Professional and scientific activities	0.11	0.37	-63.2	***	0.14	0.14	0	
Tech. services	0.13	0.03	35.2	***	0.12	0.12	0	
Business-oriented services	0.04	0.05	-3.9	**	0.04	0.04	0	
Education	0.01	0.01	-2.9	***	0.00	0.00	0	
Helth	0.01	0.03	-13.5	***	0.01	0.01	0	
Other service activities	0.04	0.03	3.2	***	0.02	0.02	0	
Capital region	0.27	0.29	-5.0	***	0.32	0.32	0	
East-Norway	0.19	0.23	-10.2	***	0.20	0.20	0	
Souht	0.18	0.16	5.9	***	0.17	0.17	0	
West	0.19	0.16	6.6	***	0.20	0.20	0	
Mid-Norway	0.11	0.08	10.4	***	0.05	0.05	0	
North	0.07	0.08	-5.0	***	0.05	0.05	0	
No. firms	7060	227934			3089	11199		
F-test		3418.44***			1.2			
^ An indicator variable for R&D>0 in the previous 3-year period. It is assumed to be zero for any new established firm.								

4.4.5 Estimation results

Table 4.9 documents the estimated α parameters for the policy effects from model (2). Other estimated parameters are not documented here in order to save space. We report two sets of results, one after matching procedure without controlling for the past R&D experience and another after matching where past R&D experience was used as an extra control variable.

We also report results from three specifications for each case of diff-in-diff estimation, i.e. where indicator for past R&D experience is not included in the set of control variables X, where it is included and where the sample of firms is restricted to the firms with positive past R&D experience only.

We find positive and significant effects of Skatte-FUNN on R&D expenditures almost for all specifications and combinations of user-generations and policy regimes with only one exception, i.e. for 2007-

2008 generation under regimes 2009-2010 and 2011-2013. This indicates that most specified user-generations actually carried out more R&D than the control group, or, in other words, that the SkatteFUNN scheme actually resulted in more R&D investments in the business population.

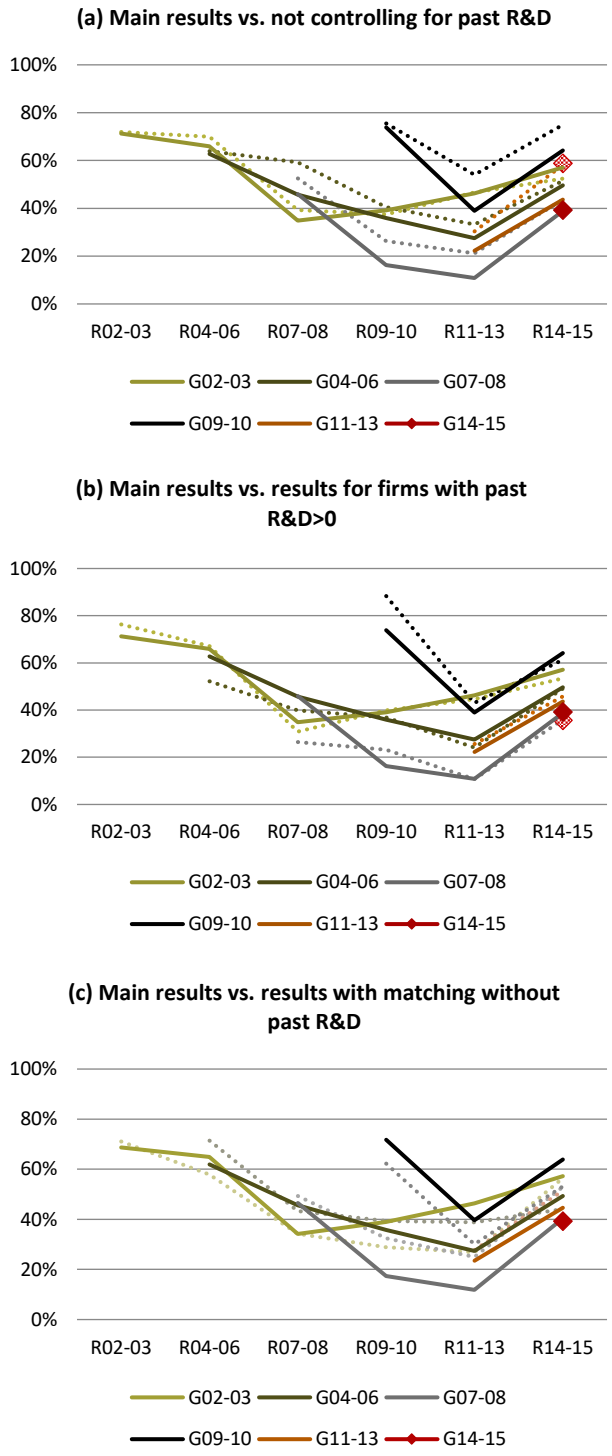
Because the dependent variable is in natural logs, the percentage effects can be calculated as *exp(α)-1*. These effects are demonstrated by Figure 4.9 where the calculated effects from the main model specification (cf. column 5 in Table 4.9) are compared with other model specifications, i.e. with results from column 4 in panel (a), from column 6 in panel (b) and from column 2 in panel (c).

Table 4.9 Diff-in-diff estimation results by policy regime and user generation (only SkatteFUNN policy effects)

Coefficients		Matching without R&D experience			Matching with R&D experience		
Generation	Regime	(1)Without control for past R&D	(2)With control for past R&D	(3) Past R&D>0	(4)Without control for past R&D	(5)With control for past R&D	(6) Past R&D>0
G02-03	R02-03	0.514***	0.546***	0.545***	0.536***	0.538***	0.567***
G02-03	R04-06	0.480***	0.452***	0.454***	0.530***	0.506***	0.514***
G02-03	R07-08	0.312***	0.300***	0.286***	0.331***	0.299***	0.269***
G02-03	R09-10	0.228***	0.255***	0.256***	0.318***	0.330***	0.336***
G02-03	R11-13	0.237***	0.232***	0.240***	0.383***	0.380***	0.369***
G02-03	R14-15	0.417***	0.440***	0.420***	0.421***	0.452***	0.428***
G04-06	R04-06	0.563***	0.545***	0.503***	0.488***	0.487***	0.420***
G04-06	R07-08	0.431***	0.359***	0.346***	0.465***	0.376***	0.336***
G04-06	R09-10	0.366***	0.337***	0.340***	0.340***	0.307***	0.314***
G04-06	R11-13	0.383***	0.328***	0.317***	0.287**	0.243**	0.216*
G04-06	R14-15	0.378***	0.365***	0.345***	0.415***	0.403***	0.399***
G07-08	R07-08	0.434***	0.404***	0.320***	0.422***	0.378***	0.235**
G07-08	R09-10	0.356***	0.278***	0.313***	0.233**	0.151	0.209*
G07-08	R11-13	0.319***	0.219**	0.233***	0.192	0.103	0.102
G07-08	R14-15	0.467***	0.418***	0.419***	0.362**	0.328**	0.307**
G09-10	R09-10	0.482***	0.488***	0.536***	0.551***	0.553***	0.633***
G09-10	R11-13	0.358***	0.252***	0.297***	0.432***	0.329***	0.358***
G09-10	R14-15	0.497***	0.421***	0.412***	0.559***	0.496***	0.478***
G11-13	R11-13	0.305***	0.238***	0.274***	0.265***	0.201***	0.228***
G11-13	R14-15	0.523***	0.411***	0.443***	0.458***	0.362***	0.377***
G14-15	R14-15	0.451***	0.337***	0.383***	0.461***	0.329***	0.304***
No. of obs.		27050	25213	21170	14610	13992	11121
No. of firms		5990	5720	4935	3489	3402	2841
No. of SKF firms		5236	4899	2780	3085	2966	1471

Notes: One, two, and three stars indicate significance at 1, 5, and 10 percent levels, respectively.

Figure 4.9 SkatteFUNN effects by user generation and policy regime.



As we can observe from Figure 4.9, the size of SkatteFUNN effects varies a lot dependent on the user-generation and policy regime. The highest effect is observed for the first generation and generation that started to use SkatteFUNN after first increase of project cost cap in 2009, while the lowest effect is observed for generation that started to use SkatteFUNN after introduction of hourly wage cap in 2007. It is even not significantly different from zero under regimes 2009-2010 and 2011-2013.

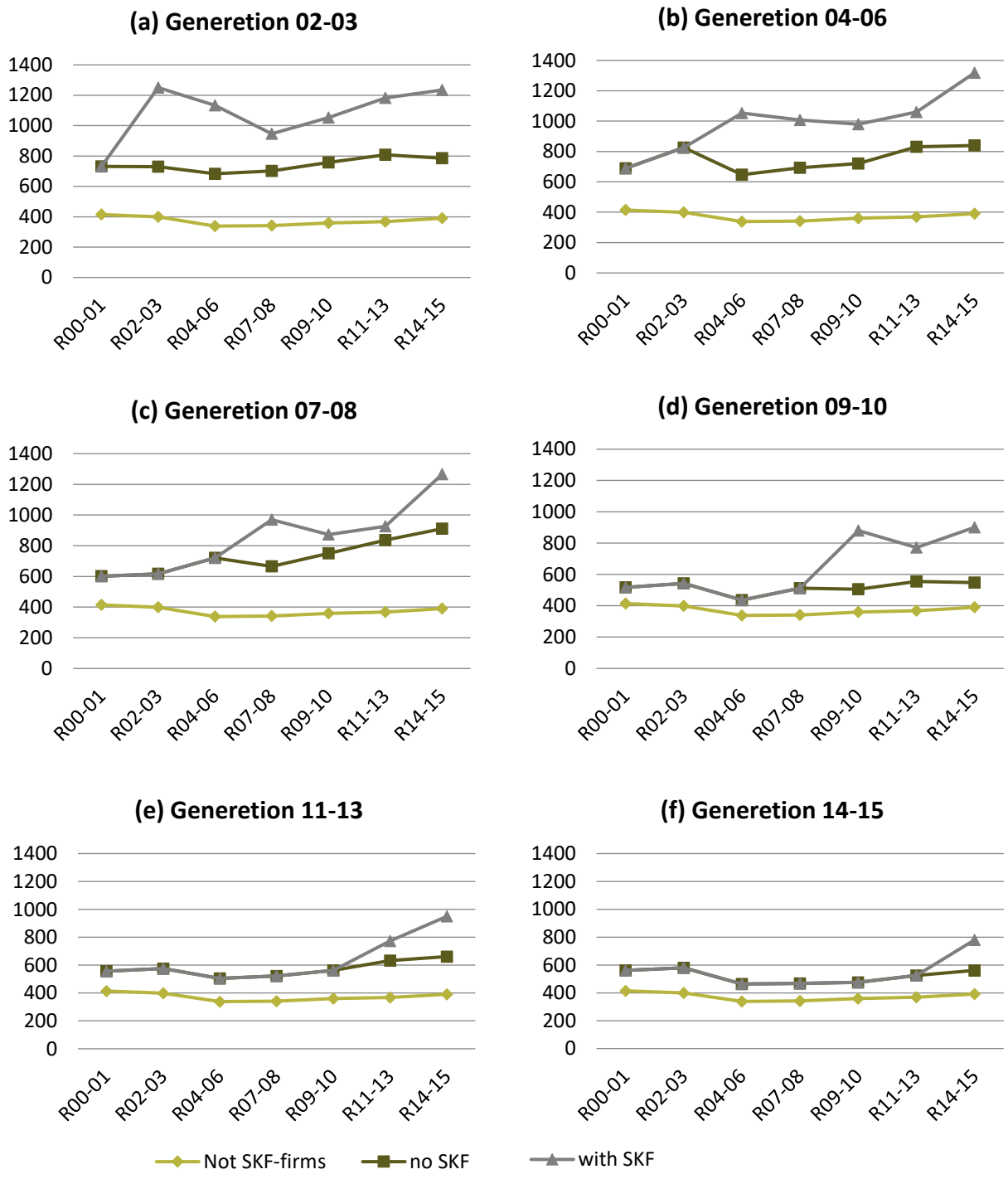
For all generations input additionality is strongest just after they started to use SkatteFUNN and is declining with time passed. However, recent significant increase in the project cost cap in 2014-2015 seems to stimulate all generations to invest more in R&D.

When we compare different model specifications, we see that not controlling for past R&D experience results in the overestimated effect of SkatteFUNN (cf. dot lines in the panel (a) of Figure 4.9).

While comparing our main results with results for firms with strictly positive R&D in the previous 3-year period (i.e. R&D-doers) we get a mixed picture. The effect for R&D doers is lower for 2004-2006 and 2007-2008 generations, slightly higher for 2002-2003 and 2009-2010 generations and similar for 2011-2013 and 2014-2015 generations (cf. dot lines in the panel (b) of Figure 4.9). The possible explanation can be that R&D doers were more stimulated by increase in the project cost caps, and more harmed by introduction of hourly wages cap than firms without R&D experience.

Finally, estimation after matching without controlling for past R&D experience gives less heterogeneous results than the main model (cf. dot lines in the panel (c) of Figure 4.9).

Figure 4.10 R&D expenditures for different SkatteFUNN-user generations by policy regime against the benchmark of no use



Source: Samfunnsøkonomisk analyse and Statistics Norway

To get a better insight into the size of the policy effects, we summarize the most important results in a graphical way Figure 4.10. Each panel of Figure 4.10 shows the predicted R&D expenditures for the different generations of SkatteFUNN-users, and non-users, over time for the hypothetical case of no SkatteFUNN existence (the counter-factual development).[47] The upper lines at each panel demonstrate the development of R&D expenditures inclusive effect of SkatteFUNN (correspondent to the given generation-policy regime combination). The difference between the upper line and benchmark is the additional R&D expenditures caused by SkatteFUNN for the given user generation.

Note, that the group of non-users of SkatteFUNN has the lowest R&D effort over the entire period. Thus, simply comparing non-users and users when estimating the policy effect will give a strongly overestimated policy result. Such differences are also observed between the different generations of users. The first two generations (G02-03 and G04-06) have the highest initial R&D effort, while last three generations (G09-10, G11-13 and G14-15) exert a remarkably lower initial R&D effort than the previous generations of users. Thus, we observe the same clear pattern as by Mohnen et al. (2017), i.e. the higher the R&D effort, the earlier the firms make use of the R&D policy (innovation box in their case and SkatteFUNN in our case).

4.4.6 Bang for the buck

We also want to know how much the BFTB measure ("bang for the buck") vary across user generations and policy regimes. This measure shows how much additional R&D has been induced per krone spent on the scheme.[48]

To calculate this measure, we need to sum up all additional R&D expenditures caused by SkatteFUNN (the area between upper line and benchmark line at each panel of Figure 4.10). It will be the generational 'bang' measure. The 'buck' is the SkatteFUNN tax deduction received by given user generation during the period of SkatteFUNN usage. Then the generational BFTB measure is obtained by dividing the generational 'bang' by the generational 'buck'.

We can also accumulate additional R&D expenditures and received tax credits for each generation-policy regime combination and get generation-policy regime specific BFTB measure. The total sum of additional R&D expenditures divided by total sum of received tax credits across generations and regimes give us the overall BFTB measure. All these calculated measures are presented in Table 4.10 based on the main model (after matching with indicator for past R&D experience as an extra control variable) and in Table 4.11 based on the alternative model (after matching without controlling for past R&D experience).

Our main model gives us the overall BFTB measure equal to 2.07 (2.04 for R&D doers). The alternative model gives slightly higher results (2.16 for all firms with past R&D information and 2-17 for R&D doers correspondently). The generation-regime specific BFTB values in Table 4.10 range from 0.65 to 3.07 showing high variation of the effects. However, most effects are much higher than 1, confirming SkatteFUNN having high input additionality.

From both tables we can see that SkatteFUNN was most effective for two first generations of SkatteFUNN users. These two generations were also most stimulated by the recent changes in the

[47] The case when all α in (2) are set to zero. i.e. we extract from the predicted values the corresponding to the generation-policy regime α value.

[48] Both R&D expenditures and tax credit amounts are deflated by R&D personal cost index.

scheme, i.e. the project cost cap increase in 2014-2015. Generation 07-08 performs most poor, followed by recent generations of SkatteFUNN users. Note also that generation 2007-2008 of R&D doers (those with past R&D>0) have very low value of BFTB under regime 2009-2010, i.e. 0.74, and 0.90 for whole period of evaluation. These numbers are not far from BFTB measure calculated in the previous chapter, possibly explaining that combination of these specific users with the period after a finical crisis gives us such low values.

The obtained results confirm strong selection of the firms into the scheme, i.e. active firms with active managers searching for opportunities and with high potential have made use of the SkatteFUNN early. While those firms who started to use SkatteFUNN recently have demonstrated a marginal achievement in doing R&D.

As for variation of the SkatteFUNN effects over policy regimes, we can observe that effects were strongest in the first two periods after SkatteFUNN introduction and slightly declining after. However, recent increase in the project cost cap in 2014-2015 has stimulated firms again to invest more in R&D. The question then how long this positive response will last is remaining for the later evaluations.

Table 4.10 "Bang for the buck": main model (after matching with controlling for the past R&D experience)

Regime	All generations	G02-03	G04-06	G07-08	G09-10	G11-13	G14-15
R02-03	2.22	2.22					
R04-06	2.68	2.86	2.41				
R07-08	2.34	2.26	2.83	1.63			
R09-10	1.95	2.21	2.38	0.74	2.15		
R11-13	1.60	3.07	1.85	0.65	1.64	0.90	
R14-15	1.66	2.34	2.47	1.42	2.17	1.45	1.15
Total	2.07	2.55	2.42	1.06	1.91	1.12	1.15
For firms with past R&D>0	2.04	2.47	2.33	0.94	1.99	1.29	1.17

Table 4.11 "Bang for the buck": alternative model (after matching without controlling for the past R&D experience)

Regime	All generations	G02-03	G04-06	G07-08	G09-10	G11-13	G14-15
R02-03	2.28	2.28					
R04-06	2.67	2.72	2.57				
R07-08	2.46	2.53	2.67	1.75			
R09-10	1.99	1.78	2.59	1.37	1.99		
R11-13	1.60	1.76	2.51	1.40	1.31	1.06	
R14-15	1.86	2.45	2.44	1.87	2.02	1.66	1.19
Total	2.16	2.36	2.58	1.55	1.68	1.30	1.19
For firms with past R&D>0	2.17	2.32	2.53	1.55	1.79	1.52	1.46

5 Output additionality of SkatteFUNN

In this chapter we have analysed the impact of SkatteFUNN on several performance indicators, including different innovation output measures, productivity and external effects. We find that SkatteFUNN contributes to more product and process innovation as well as patenting, while other types of innovation protection remain unaffected. We find that R&D investments in general, and over time, benefits the labour productivity in firms. Moreover, our results tell us that both RCN and SkatteFUNN projects have the same effect on labour productivity as other R&D projects. The external effects of R&D are difficult to measure quantitively. We apply a "distance to R&D" approach to identify spillovers, though the results of this econometric analysis are inconclusive. In the survey SkatteFUNN users report that projects have benefited the firms' customers in terms of better products or services. Moreover, a majority of respondents answered that strengthened competitiveness and dissemination of competence through staff mobility and cooperation were results of the SkatteFUNN project(s).

In chapter 4, we analysed whether SkatteFUNN stimulates firms' R&D activities (input additionality) and we have found that it does. Successful R&D projects are expected to lead to innovations, which in turn increase production and profitability. The effect of SkatteFUNN on innovation, production and profitability is called output additionality. In this chapter, we analyse the effects of SkatteFUNN on several performance indicators, specifically:

- The effect of SkatteFUNN on innovations, patents and other types of innovation protection;
- The effect of SkatteFUNN on labour productivity;
- External effects of SkatteFUNN.

The previous evaluation of SkatteFUNN (cf. Cappelen et al.,2008) found that the R&D tax credit induced firms to implement new production processes and products that were new to the firm. However, it concluded that SkatteFUNN did not result in more radical innovation in the form of new patents or products that were new to the market. Hence, the scheme seemed to support more incremental rather than more radical innovation just after its introduction (cf. Cappelen et al., 2012).

While the previous evaluation looked at the firms' innovation activities for the first 3-year period just after introduction of SkatteFUNN and compared it with 3-year period before the SkatteFUNN introduction, we study effects of firm participation in SkatteFUNN over a much longer period. In addition to Community Innovation Survey (CIS) data for 2001 and 2004 that were used in the previous evaluation, we use CIS data for 2006, 2008, 2010, 2012 and 2014 as a result applying information on firms' innovation activities during 1999-2014.[49]

Recently, a comparative analysis of tax credit schemes in Norway, France and Italy (cf. Freitas et al., 2017) that used CIS data for 2004, 2006 and 2008 for manufacturing firms, has reported a positive and significant effect of the Norwegian scheme on innovation output measured as a share of turnover from new or improved products.

Applying different models, we find that SkatteFUNN does induce firms to implement new production processes and products (both new to the firm and to the market). We also find that SkatteFUNN has a positive effect on the probability to patent, while other types of innovation protection remain unaffected.

[49] Each survey covers 3-year period.

As for the SkatteFUNN impact on productivity, the 2008 evaluation found a positive effect of the scheme both on productivity and productivity growth. The effect of SkatteFUNN was equivalent to that of other R&D activities. However, the results were too unclear to allow for any attempt to estimate the external effect of R&D in general or SkatteFUNN particularly.

A recent evaluation of selected public R&D supporting schemes (cf. Cappelen et al. (2016)) reports a positive effect of R&D capital on firm's labour productivity. This analysis looked specifically at the Research Council of Norway (RCN) and SkatteFUNN support, and found that those firms that received support from RCN or SkatteFUNN had lower return on R&D capital than those with no public support.

We apply a similar approach as in these two evaluations and find that R&D investments in general, and over time, benefits the labour productivity in firms. Both RCN and SkatteFUNN projects have the same effect on labour productivity as other R&D projects. The external effects of R&D are difficult to measure quantitively and the results of our econometric analysis are inconclusive. However, our survey among SkatteFUNN users reports that projects have benefited the firms' customers in terms of better products and/or services. Moreover, a majority of respondents stated out strengthened competitiveness and dissemination of competence through staff mobility and cooperation were results of the SkatteFUNN project(s).

5.1 Effects on innovations and patents

Business innovation is regarded as a potentially important driver of productivity growth, both at the firm and the national level. At the micro level, business innovation has the potential to increase consumer demand through improved product or service quality and simultaneously decrease production costs. At the macro level, strong business innovation increases multifactor productivity, thus increasing international competitiveness, economic growth and real per capital incomes.[50] It is therefore of great interest to businesses and policy-makers to identify the factors that stimulate innovation.

R&D is an important factor behind innovations, and together with other intangible assets, such as data, patents, new organisational processes and firm-specific skills, it makes up a firm's *knowledge-based capital,* KBC (see OECD, 2013). A lack of proper control for intangible assets and underinvestment in KBC are seen as the main candidates for explaining the poor productivity performance of European countries relative to the USA.[51] The need for Europe to move into the *knowledge-based economy* and support investment in KBC has been an important focus of government policy in European countries (see OECD, 2013) with R&D supporting programs being one of the main tools

From the previous chapter we know that firms receiving support through SkatteFUNN are more likely to increase their R&D investments than other firms. The main question in this chapter is whether these additional R&D efforts result in more innovative output.

5.1.1 Introduction of the model and estimation strategy

Let us consider a model of how innovation occurs. R&D efforts lead to innovation output. Let $INNO^*$

[50] See, for instance, Crépon *et al.* (1998), Griffith *et al.* (2006) and Parisi *et al.* (2006) for the studies at the micro level, and van Leeuwen and Klomp (2006) for the study at the macro level.

[51] See, for instance, van Ark *et al.* (2003), O'Sullivan (2006), Moncada-Paternò-Castello *et al.* (2009), Hall and Mairesse (2009) and Hall *et al.* (2013).

be a latent variable that measures the extent of creativity/research activity within the firm. The higher the value of $INNO^*$, the higher is the probability that an innovation will occur. This modelling framework is influenced by Griliches (1990), Crepon *et al.* (1998) and Parisi *et al.* (2006). The main idea in this literature is that, by investing in R&D, the firm accumulates a knowledge capital stock, which plays an important role in its innovation activities. This idea can be presented by the following equation:

$$INNO_{it}^{*} = \delta_0 + \delta_1 \cdot r_{it} + X_{it}^{inno}\beta + \eta_{it} \qquad (1)$$

where *r* is R&D intensity measure, X_{it}^{inno} is a vector of different firm characteristics important for innovation output (e.g. firm size, industry, cooperation in R&D projects etc.), δ_1 *and* β are parameters (vectors) of interest, and η_{it} is an error term.

The previous empirical studies based on this type of model use different innovation output measures to proxy unobserved knowledge, $INNO_{it}^{*}$, e.g. the share of innovative sales (applied, for example, in Crepon *et al.*, 1998, Castellacci, 2011; and Freitas *et al.*, 2017); different binary innovation indicators (applied, for example, in Griffith *et al.*, 2006, and in Capellen *et al.*, 2012, for product and process innovation; and in Polder *et al.*, 2009, for product, process and organisational innovation); and patent applications counts (applied, for example, in Crepon *et al.*, 1998).

We analyse here three types of innovations: a new (or improved) product for the firm, a new (or improved) product for the market, and a new (or improved) production process. We also use information on several types of innovation protection including patent applications, trademarks, design and copyright. In addition to these categorical measures that identify whether a firm innovates or not and whether it uses any innovation protection or not, we use information on the share of innovative sales (i.e. firm's turnover from new or improved products). We use all these innovation measures to get a better knowledge on which parts of innovation process are most affected by SkatteFUNN.

Since the CIS surveys cover a 3-year period each and are partly overlapping, we cannot provide the same detailed analysis for different SkatteFUNN regimes with respect to changes of the scheme as we did in chapter 4. However, the timing of available (to us) CIS data, with CIS2001 covering the 3-year period just before the SkatteFUNN introduction and all other CIS versions (CIS2004, 2006, 2008, 2010, 2012 and 2014) covering periods after the SkatteFUNN introduction, allows us to apply a simple diff-in-diff framework to the innovation analysis:

$$INNO_{it}^{*} = b_0 + b_1 D^1 + b_2 S_i + b_3 D^1 S_i + \delta_1 \cdot r_{it} + X_{it}^{inno}\beta + \eta_{it} \qquad (2)$$

D^1 is a dummy-variable equal to 1 for period 1 (when SkatteFUNN exists) and 0 for period 0 (when SkatteFUNN does not exist and hence no firm uses the scheme). ***S*** is an indicator for SkatteFUNN users (a dummy variable that equal to 1 if the firm has used SkatteFUNN at least once during the observational period) and 0 for the control group of firms that have never used SkatteFUNN.

Table 5.1 Overview of key variables in innovation analysis

Variable	Definition
Dependent variables:	
inpdt	1 if firm has introduced a new product for the firm in the given subperiod, 0 else
inmar	1 if firm has introduced a new product for the market in the given subperiod, 0 else
inpcs	1 if firm has introduced a new production process in the given subperiod, 0 else
turn_inno	Share of turnover from new or improved products (0-100 scale transformed to percentiles 1, 2, …, 10 in addition to 0).
patent	1 if firm has applied for a patent in the given subperiod, 0 else
trademark	1 if firm has applied for a trademark protection in the given subperiod, 0 else
design	1 if firm has applied for a design protection in the given subperiod, 0 else
copyright	1 if firm has applied for a copyright protection in the given subperiod, 0 else
Control variables:	
r	R&D intensity: R&D expenditures as a percentage of total turnover, average over the given subperiod
Δr	Additional R&D intensity generated by a tax credit, which is the treatment effect on the treated (TET) for each firm predicted from the input additionality analysis, average over the given subperiod
r^C	Counterfactual R&D intensity that each company would have done in the absence of a tax credit (obtained as the difference between *r* and *Δr* for each firm in the sample
h	Share of man-hours worked by employees with high education (14 or more years of education), average over the given subperiod
coopg	1 if firm cooperated with a firm in the group in R&D in the given subperiod, 0 else
coopf	1 if firm cooperated with another firm in R&D in the given subperiod, 0 else
coopu	1 if firm cooperated with a university or research institute in R&D in the given subperiod, 0 else
SKF_firm	1 if firm uses SkatteFUNN at least once during the whole observational period, 0 else
d_SKF	1 if SkatteFUNN tax credit > *0* in at least one year in the given subperiod, 0 else

The estimated parameter $\boldsymbol{b}_0$ then measures the average innovation effort for the control group in period 0. $\boldsymbol{b}_0+\boldsymbol{b}_1$ is the average innovation effort for the control group in period 1. $\boldsymbol{b}_2$ is the difference between the control group and the SkatteFUNN users in period 0 (this difference already exists before the policy is implemented, and is therefore not a part of the effect of the policy). $\boldsymbol{b}_0+\boldsymbol{b}_2$ is the average innovation effort for users of the policy in period 0, while $\boldsymbol{b}_0+\boldsymbol{b}_1+\boldsymbol{b}_2+\boldsymbol{b}_3$ is the average innovation effort for these firms in period 1. Hence, $\boldsymbol{b}_3$, which is the difference-in-differences, measures the 'additionality' of SkatteFUNN in terms of additional innovation effort as a result of the policy.

As mentioned earlier, given that assignment to SkatteFUNN is not random, a direct comparison of SkatteFUNN-users and non-users will give a biased result. Firms who decide to use the scheme will likely make their decision because of certain factors that are not shared with firms that do not use the scheme. Some of these factors we can observe and account for, and some of them obviously not. Then, an observed increase in innovation efforts for the users of SkatteFUNN may be the result of these specific factors, rather than of the policy itself.

To consider this selection problem we use the dataset of SkatteFUNN- and control-firms that has been constructed by propensity score matching in chapter 4. This procedure allowed for constructing the control group of firms that are comparable with SkatteFUNN firms as much as possible given their observable characteristics (cf. chapter 4.4.4 for

more details on the procedure and the description of the dataset). However, this dataset is now restricted to the firms that are represented in CIS data and, hence, does not include the smallest firms (with less than 5 employees) and many medium-sized firms (with 5-49 employees). At the same time the largest firms felt out from the data sample after matching procedure. As a result, we end up with 4577 observations where about half are SkatteFUNN-users and half are non-users with 60-70 employees as an average firm size (compared to 10 employees on average in the original matched dataset, cf. Table 4.8).

In the case of the binary innovation indicators (cf. Table 5.1 for variables description), we observe innovation, $Y_{it}=1$, if latent innovation efforts $INNO^{*}_{it}$ have been higher than some level *c*, and do not observe any innovation, $Y_{it}=0$, in the case of low innovation efforts:

$$Y_{it} = \begin{cases} 1 & if\ INNO^{*}_{it} > c \\ 0 & \text{else} \end{cases}$$

In this case equation (2) is estimated on the pooled dataset as a *probit* model. In the case of innovative sales as an innovation indicator, equation (2) is estimated as an *ordered probit* model. We use an *ordered probit* model to account for the fact that the dependent variable in this equation (firm's share of turnover from new or improved products) is defined as a categorical variable on an ordinal scale.[52]

We estimate two versions of equation (2). One version includes among the regressors the observed R&D intensity, *r*, and an indicator for participation in SkatteFUNN during a given 3-year subperiod, *d_SKF*. We call it our reference model. Another version, instead of these two regressors, includes two variables obtained by splitting the R&D intensity variable into two distinct terms. One is the additional R&D intensity generated by a tax credit (Δr), which is the treatment effect on the treated (TET) for each firm predicted from the main model for input additionality estimation in chapter 4.4. The other represents the R&D intensity that each company would have had in the absence of a tax credit (r^C; where C stands for *counterfactual*); this is simply obtained as the difference between *r* and Δr for each firm in the sample.[53] This estimation method is inspired by Czarnitzki and Hussinger (2004), Cerulli and Poti (2012) and Freitas et al. (2017). We call it our main model.

Both models also include the set of time-dummies for each CIS wave after introduction of SkatteFUNN instead of only one dummy D^1 for the whole post-introduction period (3-year pre-SkatteFUNN period covered by CIS2001 is then the reference period). At the same time, we do not distinguish here among different generations of SkatteFUNN users as we did in chapter 4.4 and apply a general indicator for SkatteFUNN-users, *SKF_firm.*

In addition to the main variables described in Table 5.1, we use the following firm characteristics in the analysis:

- *Firm size:* number of employees (log, log^2)
- *Sales intensity:* turnover per employee (log)

[52] In the surveys, the values for this variable are self-reported by the respondents and vary between 0-100 (per cent). As a result, the variable tends to be distributed unevenly and concentrated instead around a limited number of discrete values (e.g. 0, 10, 20, 30, …, 100). For this reason, we have transformed this variable into a categorical indicator taking integer values from 0 to 10 (as done in Czarntizki et al., 2011).

[53] For firms that do not receive a tax credit, the term Δr takes a value of 0, while the term r^C takes the same value as the firm's R&D intensity *r*.

- *Liquidity constrain rate:* current assets/short-term debt (log), average over the given sub-period
- *Firm age*: a number of years after establishment
- *Employees' age*: average age of employees in the given firm
- *Share of high-skilled employees:* Share of man-hours worked by employees with upper secondary education.
- *Market location*: a set of dummy variables indicating whether a firm sells its *main* products or services in local/regional, national, European or other international markets. This variable indicates the location of firm's main competitors. The former category (local/regional market location) is the reference category.
- *Received subsidy*: a dummy variable indicating whether a firm has received a subsidy for carrying out R&D during the three years of the survey.[54]
- *Firm industry*: a set of dummy variables indicating the firm industry (see chapter 2.7.1 for the description of industries in our analysis). Bioeconomic is the reference industry.
- *Firm location*: a set of dummy variables indicating the region where the firm is located, i.e. North, South, West, East, central Norway, and the capital region (Oslo and Akershus). The latter category is the reference category.

In order to assess the robustness of the results, we have also carried out the estimation procedure for two different econometric specifications of each model version. The first is the baseline specification noted above and run on the whole sample of observations. The second specification includes the lagged value of the dependent variable. This specification allows for considering the persistent nature of innovation (cf. Petters, 2009). The drawback of this strategy, however, is that we lose a sizeable number of observations (due to the unbalanced nature of our panels).

5.1.2 Estimation results for innovation types

Table 5.2 reports the results of the estimation of our reference model for different innovation output proxies (a new or improved product for the firm, a new or improved production process, a new or improved product for the market, and the share of innovative sales). While Table 5.3 reports corresponding marginal effects for some key variables on the probability of innovation.

We can see that, irrespective of innovation output indicator and of the model specification (with or without controlling for innovation persistency)[55], the propensity to innovate has a similar relationship to the main explanatory variables, increasing strongly with R&D intensity and firm's sales intensity. For example, an increase of R&D intensity by one per cent results increases the probability of a new product for the firm on average by 5.7 p.p. and the probability of a new product for the market on average by 4.5 p.p. (cf. columns 2 in Table 5.3).

Note that all types of innovation have the very significant coefficient estimate of the lagged dependent variable, Y_{t-1}, implying that innovation is a rather persistent characteristic of a firm.

[54] Note that we also control for the use of other sources of public R&D support when we do matching of SkatteFUNN-users with non-users.

[55] Results in columns (1) yield specification that does not include the lagged dependent variable, while results in columns (2) yield specification that take into account innovation persistency.

Table 5.2 Estimation results - Different innovation types. Reference model

Innovation type:	New or improved product		New or improved process		New product for the marked		Share of turnover from new products	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
R&D intensity (log)	0.273***	0.232***	0.180***	0.160***	0.253***	0.207***	0.269***	0.252***
Number of employees (log)	-0.09	-0.155	-0.238**	0.019	-0.063	-0.042	-0.014	-0.187
Number of employees (log^2)	0.015	0.026	0.041***	0.014	0.015	0.016	0.002	0.022
Turnover per employee (log)	0.056***	0.060**	0.066***	0.092***	0.033	0.038	0.040*	0.060**
Financial liquidity rate (log)	0.024	-0.046	0.008	0.023	0.018	-0.017	-0.008	-0.034
Organisational age	0.004**	0.002	0.001	-0.001	0.000	0.002	0.003	0.002
Mean age of employees	0.001	0	0.000	0.003	-0.005	-0.001	-0.008	-0.01
Share of high-skilled	0.459***	0.451**	-0.180	-0.296	0.329**	0.505**	0.260*	-0.078
Main marked: Norway	0.154***	0.113	0.099*	0.039	0.164***	0.127	0.138**	0.121
Main marked: Europe	0.09	0.134	-0.093	-0.081	-0.016	-0.112	0.035	0.133
Main marked: World	0.162*	-0.033	0.018	-0.11	0.155	-0.053	0.196**	0.193
Cooperation: in the group	0.225*	0.251*	0.090	0.094	0.145	0.146	0.023	-0.037
Cooperation: another firm	0.730***	0.653***	0.576***	0.503***	0.557***	0.386***	0.397***	0.284***
Cooperation: university	-0.075	-0.121	0.209**	0.175	0.071	0.085	-0.003	-0.082
d_subsidy	0.198	0.279	-0.061	-0.081	0.279	0.352	0.054	0.129
SKF_firm	0.207***	0.123	0.150**	0.014	0.116	0.108	0.222***	0.163
d_SKF	0.185**	0.233**	0.148**	0.203**	0.243***	0.273**	-0.041	-0.019
Y_{t-1}	-	0.790***	-	0.537***		0.717***		0.569***
Number of observations	4405	2162	4391	2161	4393	2162	3938	1841
Pseudo R2	0.30	0.34	0.18	0.20	0.27	0.29	0.25	0.15

Notes: All regressions include a constant, industry, location, and time dummies. Reference group: Local/regional market location, sub-period 1999-2001, Bioeconomic industry, firms in the capital region (Oslo and Akershus). The standard errors are robust to heteroscedasticity and clustered at the firm level. Dependent variable: binary indicators for different types of innovation or the ordinal indicator for innovative sales. Estimated by maximum likelihood as a probit model (oprobit in latter case) in Stata. *** p<0.01, ** p<0.05, * p<0.1

Table 5.3 Marginal effects for key variables - Different innovation types. Reference model

Innovation type:	New or improved product		New or improved process		New product for the marked		Share of turnover from new products	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
R&D intensity (log)	0.070***	0.057***	0.047***	0.041***	0.054***	0.045***	0.070***	0.065***
Share of high-skilled	0.118***	0.110**	-0.047	-0.075	0.070**	0.111**	0.068*	-0.020
Cooperation: in the group	0.058*	0.062*	0.023	0.024	0.031	0.032	0.010	-0.010
Cooperation: another firm	0.188***	0.160***	0.149***	0.128***	0.118***	0.085***	0.103***	0.073***
Cooperation: university	-0.019	-0.029	0.054**	0.044	0.015	0.019	-0.001	-0.021
d_SKF	0.048**	0.057***	0.038**	0.052**	0.052***	0.060***	-0.011	-0.005
Y_{t-1}	-	0.193***	-	0.137***	-	0.158***	-	0.146***
Number of observations	4405	2162	4391	2161	4393	2162	3938	1841
Pseudo R2	0.30	0.34	0.18	0.20	0.27	0.29	0.25	0.15

Notes: All regressions include a constant, industry, location, and time dummies. Reference group: Local/regional market location, sub-period 1999-2001, Bioeconomic industry, firms in the capital region (Oslo and Akershus). The standard errors are robust to heteroscedasticity and clustered at the firm level. Dependent variable: binary indicators for different types of innovation or the ordinal indicator for innovative sales. Estimated by maximum likelihood as a probit model (oprobit in latter case) in Stata. *** p<0.01, ** p<0.05, * p<0.1

Cooperation with another firm has also positive impact on the propensity to innovate for all types of innovation, while cooperation in the group has a positive impact only on the product innovation that is new to the firm.

Another key factor for innovation is employees' skills. Measured by the share of high-skilled workers in the firm, this factor has a positive impact on product innovation, but seems to be unimportant for process innovation. This result is consistent with the one obtained by Møen and Rybalka (2011).

National and international market orientation seems to have positive impact on the propensity to innovate as well. However, this result is not robust to the inclusion of the lagged dependent variable indicating the possible reverse causality (i.e. that innovation can lead to the higher market orientation level).

Interestingly, neither firm size, cooperation with universities or use of direct subsidies have any impact on the propensity to innovate. The most probable reason for that can be our sample construction procedure, when the largest firms that are main user of direct subsidies and are main collaborator with universities have been excluded under matching.

Finally, we can observe that our indicator for participation in SkateFUNN, *d_SKF*, has positive impact on the propensity to innovate for all three types of innovation. This result is robust to model specification. For example, for a representative firm the effect of a change in the value of *d_SFS* from 0 to 1 on the probability of a new product for the firm is 5.7 p.p. and on the probability of a new production process is 5.2 p.p. (cf. columns 2 in Table 5.3). However, we do not find any significant impact of SkatteFUNN on innovative sales.

Table 5.4 reports the corresponding to Table 5.9 results for our main model that estimates the effects SkatteFUNN on innovation by splitting the R&D intensity variable into two distinct terms.[56] One is the R&D intensity that each company would have done in the absence of a tax credit, r^C. The other term is the additional R&D intensity generated by a tax credit, Δr, that is predicted from the model used in chapter 4.4.

Table 5.4 Marginal effects for key variables - Different innovation types. Main model

Innovation type:	New or improved product		New or improved process		New product for the marked		Share of turnover from new products	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Additional R&D intensity, Δr	0.030***	0.047***	0.023***	0.050***	0.029***	0.041***	0.012*	0.031***
Counterfactual R&D intensity, r^c	0.070***	0.053***	0.045***	0.033***	0.051***	0.045***	0.068***	0.064***
Share of high-skilled	0.094**	0.086	-0.078**	-0.083	0.076**	0.107**	0.046	-0.066
Cooperation: in the group	0.065**	0.065**	0.030	0.030	0.038*	0.036	0.01	-0.011
Cooperation: another firm	0.197***	0.167***	0.155***	0.133***	0.126***	0.091***	0.109***	0.070**
Cooperation: university	-0.009	-0.011	0.063**	0.053*	0.022	0.027	0.011	-0.002
Y_{t-1}	-	0.203***	-	0.148***	-	0.163***	-	0.156***
Number of observations	4401	2158	4391	2151	4377	2158	3934	1841
	0.29	0.34	0.18	0.20	0.26	0.29	0.14	0.15

[56] We do not report here the corresponding to Table 5.2 results for the sake of space, but they are available upon request. These results are in general like those in Table 5.2. and lead to the same conclusons.

Notes: All regressions include a constant, industry, location, and time dummies. Reference group: Local/regional market location, subperiod 1999-2001, Bioeconomic industry, firms in the capital region (Oslo and Akershus). The standard errors are robust to heteroscedasticity and clustered at the firm level. Dependent variable: binary indicators for different types of innovation or the ordinal indicator for innovative sales. Estimated by maximum likelihood as a probit model (oprobit in latter case) in Stata. *** p<0.01, ** p<0.05, * p<0.1

Both, the counterfactual R&D variable, r^C, and additional R&D intensity, Δr, have positive and significant effects on innovation output irrespective of innovation indicator and of the model specification. This result is in line with analogous previous exercises carried out for product innovation by Czarnitzki at al. (2011) and Freitas et al. (2017).

If we compare marginal effect of additional R&D with the one of counterfactual R&D, the former is of the lower magnitude for the product innovation and of the higher magnitude for the process innovation (cf. columns 2 in Table 5.4). This result is in line with one obtained by Cappelen et al. (2012), where the strongest effect of SkatteFUNN was identified for the process innovation. However, in contrast to the results in the previous evaluation we also find a positive effect of SkatteFUNN for the new products for the marked.

5.1.3 Estimation results for patents and other types of innovation protection

In this chapter we repeat the estimation procedure as in the previous chapter, but now for the different types of innovation protection being used as the dependent variables in model (2). The types of innovation protection included in our analysis are patent applications, trademark applications, design protection and copyright.

From Table 5.5 we can see that larger and more mature firms tent to protect their innovation more often. As in the case with different innovation types, the propensity to apply for a patent or another type of innovation protection is increasing strongly with R&D intensity and firm's sales intensity.

Note that protecting innovation is also a rather persistent characteristic of a firm, i.e. coefficient estimate of the lagged dependent variable, $Y_{t-1,}$ is highly significant for all types of protection. This yields especially patent applications, i.e. given that a firm has applied for a patent in the previous subperiod, probability to apply again is 20 p.p. higher than for the firm without a patent application in the previous subperiod (cf. Table 5.6).

Firms that cooperate with other firms, are not only innovating more, but also protecting their innovation more often. Workers' skills, being important for the product innovation, also have highly positive effect on patenting.

The rest of the results have the same interpretation as for innovations except the SkatteFUNN indicators. While *SKF_firm* variable (an indicator for the scheme users) has positive and significant coefficients in the models for innovation types (implying that SkatteFUNN-users innovated more than non-users even before SkatteFUNN existence), SkatteFUNN-users do not differ in their behaviour from non-users when it yields innovation protection prior to the introduction of SkatteFUNN.

Further, an indicator for participation in SkateFUNN, *d_SKF*, has positive impact only on the propensity to apply for a patent. This result is robust to model specification. For example, for a representative firm the effect of a change in the value of *d_SFS* from 0 to 1 on the probability of applying for a patent is 5.5 p.p. (cf. columns 2 in Table 5.6). We do not find any significant impact of SkatteFUNN on other types of innovation protection.

Table 5.7 reports the corresponding results for our main model that estimates the effects SkatteFUNN on innovation by splitting the R&D intensity variable into counterfactual R&D intensity, r^C, and the additional R&D intensity generated by a tax credit, Δr.

Table 5.5 Estimation results - Different types of innovation protection. Reference model

Innovation protection:	Patent		Trademark		Design		Copyright	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
R&D intensity (log)	0.123***	0.078**	0.136***	0.102***	0.116***	0.104**	0.082***	0.102***
Number of employees (log)	0.649***	0.554**	0.663***	0.746***	0.450***	0.451**	0.632***	0.639***
Number of employees (log^2)	-0.065**	-0.049*	- 0.070***	-0.079**	-0.033	-0.036	- 0.066***	-0.060**
Turnover per employee (log)	0.102***	0.076**	0.057**	0.056*	0.05	0.092**	0.037	0.052
Financial liquidity rate (log)	-0.066	-0.092	-0.024	-0.015	-0.007	0.005	-0.007	0.039
Organisational age	0.006***	0.002	0.006***	0.006**	0.003	0.003	0.000	-0.001
Mean age of employees	0.013	0.021**	-0.007	-0.001	0.014	0.022*	-0.001	0.01
Share of high-skilled	0.425**	0.527**	0.093	0.095	0.053	0.296	0.596***	0.816***
Main marked: Norway	0.179**	0.133	0.179***	0.160**	0.205**	0.145	0.169**	0.06
Main marked: Europe	0.154	0.084	0.230***	0.018	0.239**	0.132	0.202*	0.06
Main marked: World	0.363***	0.057	0.161	0.024	0.140	0.019	0.276**	0.045
Cooperation: in the group	0.139	-0.098	0.230**	-0.03	0.252*	-0.027	0.029	-0.15
Cooperation: another firm	0.208**	0.265*	0.091	0.361***	0.191	0.533***	0.131	0.193
Cooperation: university	0.165	0.061	0.190*	0.14	-0.044	-0.131	0.124	0.19
d_subsidy	0.150	0.059	0.186	0.315	-0.113	-0.143	0.188	0.219
SKF_firm	-0.035	-0.094	0.009	-0.102	-0.104	-0.227	0.042	-0.031
d_SKF	0.258***	0.365***	0.027	0.115	-0.022	0.082	-0.12	-0.124
Y_{t-1}	-	1.329***	-	0.832***	-	1.101***	-	0.958***
Number of observations	4390	2162	4402	2156	3995	1830	3995	1830
Pseudo R2	0.18	0.29	0.14	0.21	0.16	0.25	0.13	0.19

Notes: All regressions include a constant, industry, location, and time dummies. Reference group: Local/regional market location, subperiod 1999-2001, Bioeconomic industry, firms in the capital region (Oslo and Akershus). The standard errors are robust to heteroscedasticity and clustered at the firm level. Dependent variable: binary indicators for different types of innovation protection. Estimated by maximum likelihood as a probit model in Stata. *** p<0.01, ** p<0.05, * p<0.1

Table 5.6 Marginal effects for key variables - Different types of innovation protection. Reference model

Innovation protection:	Patent		Trademark		Design		Copyright	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
R&D intensity (log)	0.019***	0.011**	0.028***	0.021***	0.014***	0.014**	0.012***	0.015***
Share of high-skilled	0.065**	0.055**	0.019	0.019	0.006	0.040	0.085***	0.124***
Cooperation: in the group	0.021	-0.015	0.047**	-0.006	0.031*	-0.003	0.004	-0.023
Cooperation: another firm	0.032**	0.040**	0.019	0.074***	0.024*	0.072***	0.019	0.029
Cooperation: university	0.025*	0.010	0.039*	0.029	-0.005	-0.017	0.018	0.028
d_SKF	0.039***	0.055***	0.006	0.023	-0.003	0.011	-0.017	-0.019
Y_{t-1}	-	0.200***	-	0.170***	-	0.150***	-	0.146***
Number of observations	4390	2162	4402	2156	3995	1830	3995	1830
Pseudo R2	0.18	0.29	0.14	0.21	0.16	0.25	0.13	0.19

Notes: All regressions include a constant, industry, location, and time dummies. Reference group: Local/regional market location, subperiod 1999-2001, Bioeconomic industry, firms in the capital region (Oslo and Akershus). The standard errors are robust to heteroscedasticity and clustered at the firm level. Dependent variable: binary indicators for different types of innovation protection. Estimated by maximum likelihood as a probit model in Stata. *** p<0.01, ** p<0.05, * p<0.1

Table 5.7 Marginal effects for key variables - Different types of innovation protection. Main model

Innovation protection:	Patent		Trademark		Design		Copyright	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Additional R&D intensity, Δr	0.011**	0.022***	-0.003	0.003	0.002	0.010	-0.006	-0.011
Counterfactual R&D intensity, r^c	0.025***	0.018***	0.029***	0.024***	0.016***	0.016**	0.014***	0.018***
Share of high-skilled	0.092***	0.083*	0.021	0.001	0.005	0.050	0.079***	0.111**
Cooperation: in the group	0.027	-0.009	0.048**	-0.006	0.034**	0.001	0.001	-0.023
Cooperation: another firm	0.033**	0.045**	0.024	0.083***	0.027*	0.080***	0.022	0.037
Cooperation: university	0.022	0.004	0.040*	0.030	-0.009	-0.026	0.015	0.026
Y_{t-1}		0.197***		0.169***		0.152***		0.145***
Number of observations	4382	2158	4398	2158	3988	1807	3988	1821
	0.19	0.29	0.14	0.21	0.17	0.25	0.14	0.19

Notes: All regressions include a constant, industry, location, and time dummies. Reference group: Local/regional market location, subperiod 1999-2001, Bioeconomic industry, firms in the capital region (Oslo and Akershus). The standard errors are robust to heteroscedasticity and clustered at the firm level. Dependent variable: binary indicators for different types of innovation protection. Estimated by maximum likelihood as a probit model in Stata. *** p<0.01, ** p<0.05, * p<0.1

We observe the same pattern here. While the counterfactual R&D variable, r^C, has positive and significant effects on innovation protection irrespective of protection indicator and of the model specification, the additional R&D intensity, Δr, has positive effect only on patents.

All in all, our analysis provides a clear and robust evidence on the existence of output additionality for Norwegian R&D tax credit scheme, i.e. that participation in SkatteFUNN results in the creation of new products and processes, an increase in firms' turnover from new products and in more patenting.

5.2 Effects on productivity

In the following, we will look at what effect R&D investments have on firm performance, more specifically, what effect SkatteFUNN has on productivity in firms.

It is reasonable to assume that R&D investment carried out today yields a return tomorrow. Our analysis is therefore based on an economic model of firm behaviour where accumulated R&D investment, or R&D capital, is the relevant explanatory variable when we seek to estimate the effect of R&D on productivity. By assessing which mechanisms have been present and estimating parameters in an economic model that follow from assumptions, we can calculate the return on R&D capital. Both our model and R&D capital specification follows that of Cappelen et al (2016), meaning that, for all practical purposes, our estimation is a reestimation using longer time series. The following outlines the theoretical background for our empirical analysis.

5.2.1 Calculating R&D capital

Statistics Norway's R&D statistics do not give any information about firms' R&D capital, but rather their yearly R&D investment. We therefore construct a

time series for R&D capital in each firm in our sample. For the firms who reported no R&D investment in any year of the R&D survey, the R&D capital is zero. For firms with positive R&D investment, we estimate R&D capital using the "perpetual inventory method" (PIM). Based on firms' gross R&D investment in every year (J_t), R&D capital (F_t) is estimated using the following equation:

$$(5.1)\quad F_t = J_t + F_{t-1} - D_t = J_t + (1-d)F_{t-1}.$$

D_t denotes the depreciation of initial capital stock during the year. All variables are deflated using a gross R&D investment price index. This is standard practice in National accounts. The first equation says an increase in capital (F_t-Ft_{-1}) equals investment minus depreciation (J_t-D_t). The next step involves a decision on depreciation.

Standard in the literature, is an assumption of depreciation equalling a fixed share of capital each year, thus making $D_t = d*F_{t-1}$. Inserting this in place of D_t in equation 5.1, leads to the expression on the right-hand side. By repeated insertion, F can be written as a weighted sum of investment over time and the initial capital stock (F_0).

Since F_0 cannot usually be observed, we estimate the initial capital stock assuming firms were in equilibrium in the initial year. That is, gross investments amounted to what was required to reproduce capital along an even growth path, characterized by a growth rate "g". This means $F_0 = J_1/(g+d)$. We set d = 0.15, which is standard in the literature.[57] We estimate g by using the time series for firms in our sample.

Inserting the estimated value for the initial R&D capital stock for each firm, we use the equation 5.1 to calculate F_t for each firm. With this method, firms with no R&D investment one year, still has R&D capital if it made R&D investment in a previous year.

5.2.2 Theoretical model and econometric specification

In the following, we put forward a theoretical model to explain what mechanisms we allow for and how we suppose R&D capital affects value added. Further, we present our econometric specification.

Note that, since we are talking about R&D capital, R&D investment back in time can have a positive effect on firms' value added years later. However, recent R&D investments count more than earlier ones, since investments depreciate over time.

Also note that, when analysing the effects of R&D capital in total, support from SkatteFUNN and The Norwegian Research Council is treated symmetrically and in total. This approach has empirical support in Cappelen et al (2013). The Norwegian Research Council register their support with the contract partner, while R&D activity also occurs in the collaborating partners (firms). We avoid this problem in the data by utilizing the R&D statistics, which register actual R&D expenses, regardless of how the R&D is funded.

Many firms in Statistics Norway's R&D survey report no R&D investments in the annual R&D surveys. Thus, they have zero R&D capital. Several analyses of R&D return remove these firms from the sample used in estimation. This is potentially a drastic selection, since it involves an idea of "the effect of something can only be estimated among those doing this something". An analogy could be estimating the effect of smoking, but only including those who smoke in the sample. As Cappelen et al (2016), we

[57] Under certain conditions it can be shown that this means R&D investments has a life expectancy of about 13 years. 15 % depreciation is high, considering this means R&D investments are "reduced in value" already the year after the investment was made and few R&D investments are expected to give a return within one year. There are alternatives to this depreciation, and the choice influences the results. However, we choose this value since it is standard in the literature and allows a comparison to previous estimates, i.e. Cappelen et al. (2016).

do not agree with such a strategy, a priori. The consequence of including firms with zero R&D capital is that our model must allow for positive production although R&D capital equals zero. This has implications for which functional form we can use.[58]

In Cappelen et al (2013), a similar issue is analysed using equivalent data. Assume there are two inputs in production; labour (L) and R&D capital (F). Together they produce gross value added (Y). The production function specified in Cappelen et al (2013) can, in a simplified version, be written as

$$(5.2)\ Y = \gamma_0 L^a (bL + F)^{1-a}.$$

Here, γ_0 and b are constants and a is a parameter. Setting b = 0 would mean (5.2) corresponds to a simple Cobb-Douglas function. As can be seen, F = 0, allows Y>0, meaning this functional form allows for zero R&D capital and positive production.

In this study, we will adopt a slightly different approach to that of Cappelen et al (2013). We assume firms produce heterogenous products that face falling demand curves. More specifically, demand for a product falls when the firm increases its price, but if all prices increase just as much, in percentage terms, and income follows the general price increase, demand for any firm's product does not change. Further, we assume that firms use labour, goods, R&D capital and other real capital as inputs in their production. Firms can have zero R&D capital, but must have positive real capital otherwise. We assume R&D capital contributes to labour productivity, not the efficiency of use of goods.

With these assumptions, one can establish a relation between labour productivity, measured as value added per hour worked, the relationship between the price of goods and labour and factors affecting efficiency in the use of labour, including R&D capital. We allow for a separate effect on productivity from highly educated labour by including the share of highly educated labour in firms.

$$(5.3)\ ln(\frac{y}{L})_{i,t} = c_{0,i} + c_1 D_t + c_2(\frac{F}{L})_{i,t} + c_3(\frac{H}{L})_{i,t} + c_4 D_{i,j,t} + u_{i,t}$$

The model includes firm fixed effects, $c_{o,i}$, a variable D_t which captures common shocks in each year included in the analysis, the variable F/L which shows how much R&D capital per employee is present in each firm at the start of each year, the share of highly educated employees in each year, denoted by the expression H/L, and a set of dummy variables $D_{i,j,t}$ capturing each firm's industrial affiliation, region, age and whether the firm cooperated with others in regard to their R&D activity. The right-most variable in equation (5.3), $u_{i,t}$, is an error term which we allow to vary with itself in previous periods (auto correlated residuals that follow an AR(1) process), which is a way of capturing sluggishness in changes in firms' adaptation. If we put y = ln(Y/L), f = F/L and h = H/L, a dynamic version of (5.3) that allows for autocorrelated residuals would look like

$$(5.4)\ y_{i,t} = a y_{i,t-1} + b_{0,i} + b_1 D_t + c_2 f_{i,t} + b_2 f_{i,t-1} + c_3 h_{i,t} + b_3 h_{i,t-1} + \sum j\, b_{4j} D_{i,j,t} + e_{i,t}$$ [59]

We want to test the null hypothesis; projects subsidised by RCN and SkatteFUNN has the same productivity effect as other R&D projects, against the alternative hypothesis; projects subsidized by RCN and SkatteFUNN has a lower productivity effect than other R&D projects.

To test the null hypothesis, we include dummy variables for RCN support and SkatteFUNN separately

[58] The following requires some knowledge of mathematical analysis. The reader can skip to the text starting after equation (5.4) to avoid technical details.

[59] Here, $b_{0,I} = (1\text{-}a)\, c_{o,i}$, $b_1 = (1\text{-}a)\, c_1$ $b_2 = -\, a\, c_2$, $b_3 = -\, a\, c_3$ and $b_4 = (1\text{-}a)\, c_4$, where a is the parameter of autocorrelation

which interact with firms' R&D capital and takes the value 1 if the firm has received support from RCN or SkatteFUNN and 0 if the firm never received support from RCN or SkatteFUNN.[60]

We expect the effect of the dummy variable interactions to be negative. That is, we expect that RCN and SkatteFUNN support contributes to lowering the marginal return to R&D. This is because projects with public support are, by definition, not fully financed by the firms, and hence have a lower expected payoff for the firms, otherwise they would have done the projects without applying for RCN support or using SkatteFUNN. Moreover, a negative effect is in line with the previous evaluation of public R&D support (Cappelen et al., 2016).

The above specification and our estimation method means we must observe firms for at least three years in a row, in order for them to be included in the estimation of the parameters of equation (5.4). The results reported in table 5.9, are generated using an estimation method that both allows for autocorrelated residuals[61] and differences in equation (5.4) to eliminate the firm fixed effect $b_{o,i}$ (which also means variables dated year t, t-1 and t-2 are included).[62] Even after imposing this restriction of having to observe firms for at least three years, we are still left with unreasonable firm observations; for example negative value added. These firms are excluded from the analysis. We also exclude some observations where the relationship between R&D capital and productivity is unreasonably strong. In the data, we also observe some "new" firms with a high level of R&D investments as share of value added. These are most likely not new firms, but separated divisions of larger firms, and we therefore exclude some of the more R&D intensive firms in this group.

There are 2149 firms in our estimation sample. Table 5.8 shows some descriptive statistics on the number of firms in different categories in the estimation sample.

Table 5.8 Descriptive statistics on the number of firms in different categories in the estimation sample. 2003-2015.

Year	No. of firms	No. of firms with Skatte-FUNN	No. of firms with main support from SkatteFUNN	No. of firms with RCN support	No. of firms with main support from RCN	No. of firms with both RCN and SkatteFUNN funding	No. of firms with positive R&D investment, but no RCN or Skatte-FUNN funding
2003	968	259	249	36	22	24	211
2004	1095	342	332	43	25	28	189
2005	1228	338	319	88	49	58	213
2006	1271	332	308	153	86	91	204
2007	1269	277	243	186	121	99	215
2008	1228	259	223	186	122	100	222
2009	1234	281	244	214	146	105	203
2010	1327	292	261	234	154	111	203
2011	1343	282	244	247	173	112	193
2012	1386	299	253	273	197	122	196
2013	1416	320	271	288	210	127	180
2014	1318	347	292	307	209	153	158
2015	1137	378	319	314	193	180	123

[60] These interaction expressions are not included in (5.4) for the sake of simplicity.
[61] Previous results evidence the existence of autocorrelated residuals. See Cappelen et al (2016).
[62] GMM denotes "generalized method of moments". More specifically we have utilised an estimation method conceived by Arellano and Bond (1991), which is an instrumental variable method. Sargan tests are employed to verify the validity of our instruments.

5.2.3 Results

The results are reported in table 5.9, where the results are separated in two. In the column called "Model of reference", we report the results of the core model where we do not include dummies for who firms receive support from. The column called "Main model" reports the model where dummies for RCN and SkatteFUNN support are included. This model is the most relevant one in evaluation terms, since it tells us whether SkatteFUNN support increases (or decreases) the return to R&D capital.

Overall, the results show that R&D capital has a positive effect on productivity, but that neither SkatteFUNN nor RCN support contributes to lessening or strengthening the effect. The latter leads to the conclusion that both SkatteFUNN and RCN supported projects lead to the same productivity effect as projects without public funding. As Table 5.9 shows, the estimated coefficient for R&D capital interacted with a dummy for SkatteFUNN as main support is positive and significant at the 10 percent level, though only barely so. This result is however not very robust, so we choose to dismiss the significance reported, in line with other results that are not reported here.

The results are sensitive with respect to sample selection.[63] We put most weight on the estimated return to R&D capital in the reference model, since it is relatively more robust than results obtained using the main model, as well as being in line with the results of Cappelen et al. (2016).

[63] In the results reported, we exclude the top and bottom 1percent of predicted values from a quantile regression log productivity as the dependent variable with year and industry dummies. We also drop observations based on the top and bottom 1 percent of R&D intensity and the top 5 percent of newly established firms by R&D intensity.

Using GMM estimation involves the use of instruments. Thus, we use Sargan tests[64] to validate our instruments. Whether this test accepts our instruments is also sensitive to sample selection. However, our instruments are valid for the data we use and in the models behind the reported results, as evidenced by the reported Sargan tests.

As mentioned above, we trust the results reported in the reference model column more than that of the main model. The estimated average marginal return to R&D capital is 8.2 percent, in line with the results of Cappelen et al (2016). This rate of return can be interpreted as a net return rate after depreciation of R&D investment of 15 percent is subtracted.[65] Note that this is an average effect of all R&D capital, including, and not differentiating between, R&D capital stemming from R&D investments that were supported by RCN and SkatteFUNN.

When considering the estimated R&D elasticities and marginal return to R&D in the main model, note that the estimates for those with SkatteFUNN and

Table 5.9 Estimated productivity equations, 2003-2015. Dependent variable y = ln(Y/L)

	Main model		Model of reference	
Explanatory variables	Short term coefficients	Long term coefficients	Short term coefficients	Long term coefficients
y_{t-1}	0.36 (0.01)***		0.384 (0.023)***	
f_t	0.156 (0.006)***	0.052 (0.008)***	0.182 (0.015)***	0.178 (0.018)***
f_{t-1}	-0.122 (0.006)***		-0.073 (0.012)***	
d_nfr x f_t	0.024 (0.003)***	-0.007 (0.011)		
d_nfr x f_{t-1}	-0.028 (0.006)***			
d_skf x f_t	0.023 (0.01)**	0.037 (0.022)*		
d_skf x f_{t-1}	0.0 (0.01)			
h_t	0.292 (0.079)***	0.257 (0.103)**	0.217 (0.127)*	0.327 (0.18)*
h_{t-1}	-0.127 (0.064)**		-0.016 (0.103)	
Cooperation with R&ED[1]	0.032 (0.007)***		0.019 (0.012)	
Cooperation with other firms	0.003 (0.005)		0.011 (0.008)	
Estimated R&D elasticity	0.004 (no support)	0.008 (RCN support) / 0.012 (SkatteFUNN support)	0.02	
Estimated marginal return from R&D	0.023 (no support)	0.027 (RCN support) / 0.039 (SkatteFUNN support)	0.082	
Observations	11 304		11 304	
Number of firms	2 149		2 149	
Wald chi test	26 844.98		2 418.28	
Sargan test (prob > chi)	0.088		0.055	

[1] R&ED stands for research and educational institutions

Standard errors in parenthesis. * significant at 10percent, ** significant at 5 percent, *** significant at 1percent

Dummy variables for firm age, region, industry and time dummies are included, but not reported

d_nfr = 1 if firm has RCN as main support in year t, d_skf = 1 if firm has SkatteFUNN as main support in year t

[64] The Sargan test was first published in Sargan (1964). It is a test of the validity of the instruments used in regression. If the instruments are valid, they are uncorrelated with the residuals. If the test statistic is larger than the critical value, we reject the zero hypothesis that all instruments are valid, and conclude that at least one if not exogeneous.

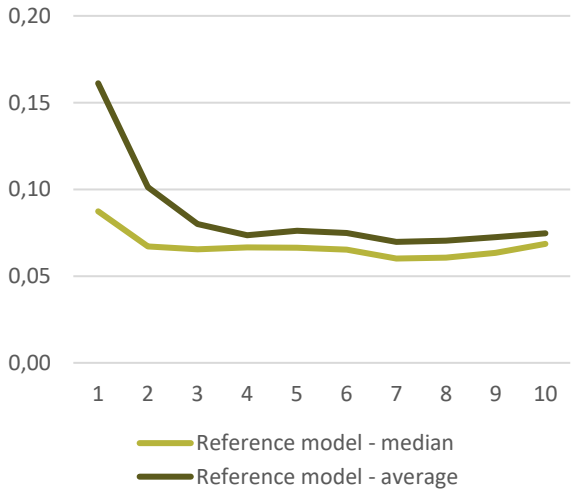
[65] In our measure of value added (Y), we use information from the R&D statistics to remove internal R&D costs (wages and goods). In addition, internal R&D personnel is removed from labour (L).

RCN support are not significantly different from those with no support.

In both the reference model and the main model, results show that labour productivity is higher the higher the share of highly educated employees. Further, the effect of collaboration with research and educational institutions is positive and significant in the main model.

In Figure 5.1, we show the estimated marginal return to R&D capital in the reference model, by deciles of R&D intensity. The figure shows that for a level of R&D intensity above the fourth decile of the distribution, the rate of return is quite similar. Also, the rate of return is quite stable and evenly distributed among the firms, since the median and average are similar. For those firms at the 35-40 percent bottom part of the distribution of R&D intensity, the rate of return to R&D capital is more uneven, with some relatively high rates of return making the average higher than the median. Still, the median is relatively stable for all ten deciles, and shows little variation in the rate of return, except at the bottom and upper deciles. This is in line with Cappelen et al (2016).

Figure 5.1 Estimated average and median marginal rates of return to R&D capital by deciles of R&D intensity. 2003-2015.



Source: Samfunnsøkonomisk analyse

Our main results from the econometric analysis are:

- The estimated effect of R&D capital on labour productivity is positive and significant. The marginal return to R&D capital is calculated to be about 8 percent
- Neither the effect of RCN nor SkatteFUNN projects are significantly different to that of other R&D projects.

The conclusions of both of the above bullet points are in line with the previous evaluation, by Cappelen et al (2008).

The implication of our results is that with respect to effects on firms' labour productivity, R&D projects with public funding is not significantly different from projects without.

5.3 External effects of SkatteFUNN

To consider the full economic effects of R&D we must consider potential externalities. There are several possible spillovers from R&D. One potential spillover is the spreading of results or competence through cooperation in R&D projects or through staff mobility. Another possible external effect is that improved products or services lead to lower prices through market competition. Improved quality of products or services can also benefit the demand side. In the cases the demand side are firms, then lowered prices or improved products or services could benefit them in terms of increased productivity, margins or sales if they themselves improve their products or services as a result of their suppliers' innovation.

To assess the magnitude of this, we follow a classic approach in the literature, which equals that of the previous evaluation of SkatteFUNN.

5.3.1 Theoretical model and econometric specification

The idea is that the closer you are to others R&D activity, the more you benefit from it. In practice, this "proximity" can be measured as geographical proximity or in terms of industrial affiliation; firms are "close" if they are in the same industrial division. In theoretical terms, this means we assume that firms' production functions depend on aggregate R&D at the industry and regional levels. We will use county and industrial division, as specified by Industrial Classification SN2007, NACE Rev. 2.[66]

We calculate R&D intensities, meaning R&D investment per employee, by industry division and county. Then, these groups are ranked from high R&D intensity to low, using percentiles by industry-year and county-year. We use these rankings to make dummies, which are then interacted with R&D capital in our model specification in part 5.2.2. Thus, our model is simply an expansion of the above.

To conclude, we allow spillovers both in the geographical dimension and on the industry level, as well as allowing for these effects to differ between the two dimensions and between (i) those with SkatteFUNN projects, (ii) those without SkatteFUNN projects but who have been R&D active at some point in the time period we analyse and (iii) those with no R&D activity. Results are reported below, in relative terms to those who are in industries and counties with high R&D intensity.

5.3.2 Results

The results, reported in Table 5.10, show that both R&D capital and the share of highly educated employees in firms have positive and significant effects on labour productivity, as in the productivity analysis presented above. For firms with no R&D capital, the effect of being in a county or industry with low or medium level of R&D intensity relative to a high level of R&D intensity is not significant. That is, the results indicate no spillovers on firms without R&D activity.

However, we conclude that the econometric analysis is inconclusive as to the external effects of R&D for those who are R&D active. While estimates show that firms in industries with medium R&D intensity have a relatively lower return to R&D capital than firms in industries with a higher level of R&D intensity, which is as expected, the estimates also indicate that firms in counties with a low R&D intensity have a relatively higher return to R&D than firms in counties with a high R&D intensity. This does not make sense logically, and we cannot say one estimated coefficient is "correct" or valid and one is not, within the same regression. This leads us to conclude that we are not able to quantitively assess the potential external effects.

In Technopolis' web survey, firms were asked what impact their SkatteFUNN projects might have contributed to outside the firm. The most frequently reported impact was that the projects have benefited the firms' costumers, mainly in terms of better products or services, cf. Figure 5.2. This is also linked to the second highest rated external impact, strengthened competitiveness for other firms.

Since the main customers of 78 percent of firms are other firms, improved products and services are instrumental in making their customers' operations more efficient or delivering better products or services to their customers, thus ultimately making also them more competitive. Dissemination of competence through staff mobility and cooperation was the third highest rated external impact. A majority of SkatteFUNN projects involve some form of cooperation, either with an R&D institution or with other firms. Consequently, many opportunities for sharing

[66] http://www.ssb.no/en/klass/klassifikasjoner/6/

of competence appear in projects, and we have noted that SkatteFUNN enables firms to expand projects from exclusively internal to involving external project partners. Moreover, 45 percent of respondents agreed that projects have contributed to strengthening of the competitiveness for R&D institutions (who have participated in projects).

It is desirable that innovation and development that leads to growth in firms is sustainable and environmentally friendly. Firms were asked if their SkatteFUNN projects (e.g. through the products or services that has been developed) have had an impact in terms of improvement to the external environment (48% of survey respondents agreed) or reduced energy consumption, i.e. more efficient use of energy (40% of respondents agreed).

Table 5.10 Estimated productivity equations including external effects, 2003-2015. Dependent variable y = ln(Y/L)

	Models including external effects		
Explanatory variables	Combined effects	Only industry effects	Only county effects
y_{t-1}	0.377 (0.023)***	0.381 (0.023)***	0.373 (0.022)***
f_t	0.165 (0.016)***	0.168 (0.015)***	0.162 (0.016)***
f_{t-1}	-0.072 (0.014)***	-0.069 (0.014)***	-0.075 (0.016)***
d_low_industry	-0.187 (0.242)	-0.212 (0.245)	
d_med_industry	-0.002 (0.036)	-0.002 (0.036)	
d_low_county	-0.017 (0.095)		-0.02 (0.095)
d_med_county	0.146 (0.183)		0.142 (0.183)
d_low_industry x f_t	0.323 (0.528)	0.408 (0.531)	
d_med_industry x f_t	-0.093 (0.053)*	-0.089 (0.048)*	
d_low_county x f_t	1.247 (0.4)***		1.308 (0.391)***
d_med_county x f_t	0.02 (0.201)		-0.191 (0.164)
d_low_industry x d_skf x f_t	-0.25 (0.577)	-0.271 (0.577)	
d_med_industry x d_skf x f_t	-0.168 (0.06)***	-0.178 (0.06)***	
d_low_county x d_skf x f_t	-0.277 (0.144)*		-0.337 (0.142)**
d_med_county x d_skf x f_t	0.005 (0.049)		-0.036 (0.045)
h_t	0.217 (0.128)*	0.213 (0.127)*	0.212 (0.128)*
h_{t-1}	-0.028 (0.104)	-0.019 (0.104)	-0.021 (0.104)
Cooperation with R&ED[1]	0.019 (0.012)	0.018 (0.012)	0.019 (0.012)
Cooperation with other firms	0.011 (0.008)	0.01 (0.008)	0.012 (0.008)
Observations	11 304	11 304	11 304
Number of firms	2 149	2 149	2 149
Wald chi test	2 397.61	2 356.75	2 292.36
Sargan test (prob > chi)	0.053	0.054	0.045

[1] R&ED stands for research and educational institutions

Standard errors in parenthesis. * significant at 10percent, ** significant at 5 percent, *** significant at 1percent

Results for low and medium R&D intensity industries and counties are relative to high R&D intensity industries and counties.

Dummy variables for firm age, region, industry and time dummies are included, but not reported

d_low_industry = 1 if firm is in an industry with a low R&D intensity, d_med_industry = 1 if firm is in an industry with a medium R&D intensity,

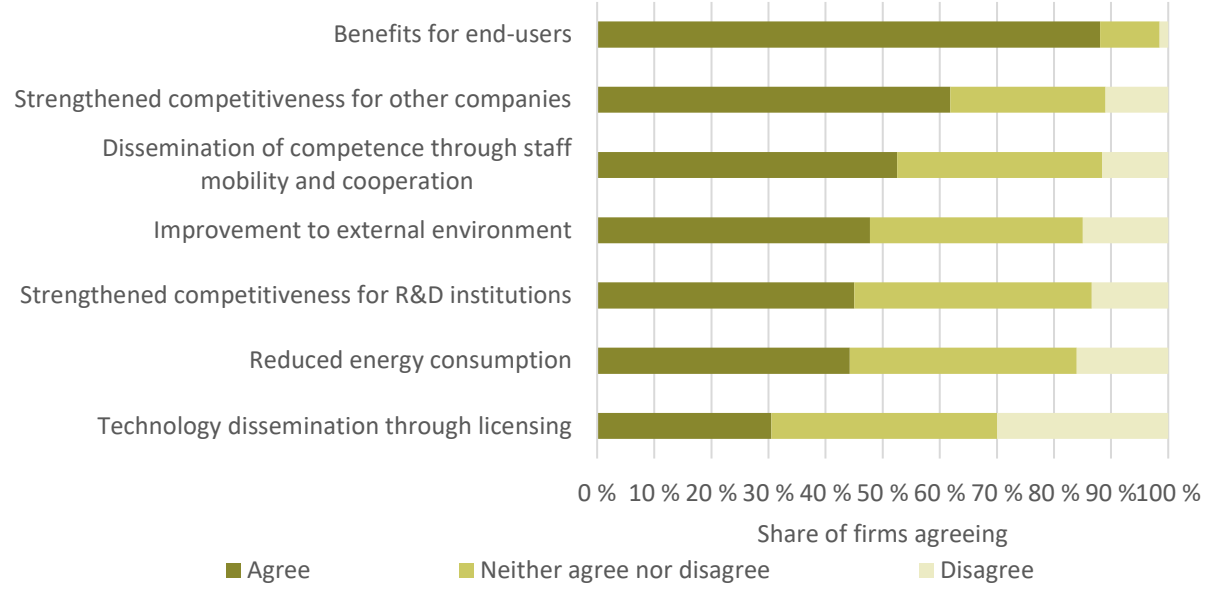
d_low_county = 1 if firm is in a county with a low R&D intensity, d_med_county = 1 if firm is in a county with a medium R&D intensity.

d_skf = 1 if firm has SkatteFUNN as main support in year t

To further illustrate how this has been achieved we present some examples from interviewed firms:

- Development of new equipment that make electric bikes more efficient and durable thus enabling them to become a more attractive alternative to car travel (micro-enterprise within Computer programming, consultancy and related activities)
- New products that enable increased use of wood based materials in construction of buildings (firm within manufacture of wood and of products of wood and cork)
- Introduction of new chemical refrigerant mediums that lead to reduced carbon dioxide emissions (firm within manufacture of fabricated metal products, except machinery and equipment)
- Value creation in reuse of residual materials from fish farming (micro-enterprise within social work activities without accommodation)

Figure 5.2 Firm's view on SkatteFUNN project(s) contributing to impact outside the firm. N=575.



Source: Technopolis web survey

6 What types of R&D is stimulated by SkatteFUNN?

The most frequently reported R&D type is development of entirely new technical solutions, followed by testing and implementation of technical solutions new to the firm. This indicates that SkatteFUNN are first, and foremost development projects directed towards improvement of the firms' products or services.

That most SkatteFUNN projects are development projects is confirmed in project data provided by the Research Council. Approximately 85 percent of all approved projects are categorised as development.

Successful R&D projects lead to innovations. SkatteFUNN recipients report on results of their projects to the Research Council. In these data, we find that the median number of innovations attained per project is 1. Indeed, 62 percent of all SkatteFUNN projects have resulted in one or more innovations.

Data of indicate that SkatteFUNN projects have the same possibility to be new to the market as project supported by RCN in general. For both the possibility is higher than project supported by IN. Regarding intellectual property rights, of all initiated SkatteFUNN projects, about 14 percent of projects achieve one or more patents.

As part of the evaluation we identify what kind of R&D SkatteFUNN supports. We focus on basic research, applied research and development. This is a distinction known from the Frascati manual.

In this chapter we investigate what SkatteFUNN results in with a broader set of indicators:

- Innovations
  - Process innovations
- R&D types:
  - Basic research
  - Applied research
  - Development
- Levels of intellectual property right:
  - Patent applications
  - Design applications
  - Trademark applications

To consider these matters, we use information from our survey and interviews and the R&D and innovation surveys conducted by Statistics Norway, as well as SkatteFUNN project data.

6.1 Most projects are development of new technical solutions

Figure 6.1 shows the level of agreement with alternatives regarding the type of R&D conducted in the latest SkatteFUNN project in our survey.

The most frequent type of R&D is development of entirely new technical solutions (67 pct. on average, while 78 pct. for firms in professional, scientific and technical activities), followed by testing/implementation of technical solutions new to the firm (47 pct.). Development of new/improved services or products were selected by around a third of firms, and development to expand use of existing products/services by a quarter.

These results imply that the typical SkatteFUNN project has an applied focus that is directly connected to development or improvement of the firm's products or services. The same pattern is confirmed in our interviews, where a clear majority of firms relate project activities to their core products or services., which also explains why so many firms rate their projects as strategically important.

Firms that had multiple projects nevertheless seem more likely to use some SkatteFUNN projects for more long-term strategic development, and other projects for more direct development of current products or services.

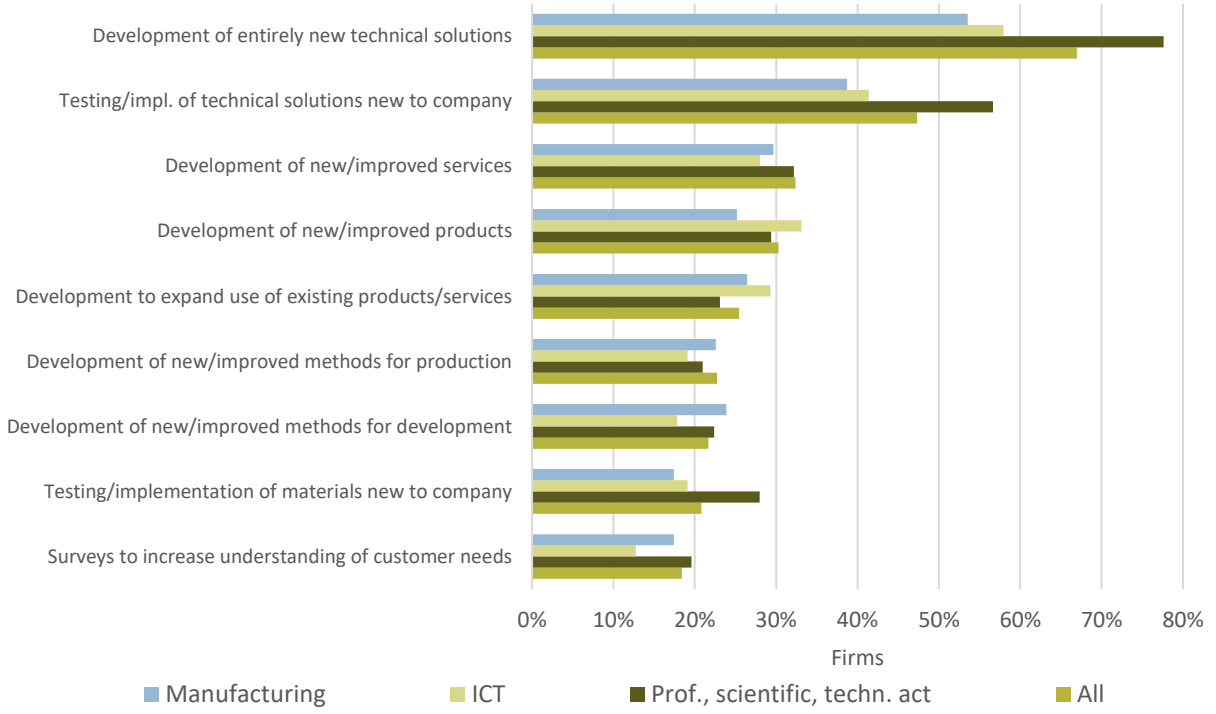
The interviews also indicate that most firms used SkatteFUNN for clearly defined development activities in the firm. In contrast, a few interviewees described a situation with several activities that formed the basis for a SkatteFUNN project, but this had made it more difficult to adequately report the main project activity.

We have heard many examples by interviewees describing how SkatteFUNN works complementary to other public funding schemes, and combining SkatteFUNN with different schemes offered by Innovation Norway seems to be the most common. From officials in Innovation Norway, as well as through interviews with users, we have learned that SkatteFUNN is seen as the foundation for public R&D funding.

At the same time, SkatteFUNN has a far broader target group, and only a minority of SkatteFUNN users are eligible for support from Innovation Norway. The latter group is advised to apply for SkatteFUNN and add funding from Innovation Norway "on top". According to several interviewees, combining different public schemes for the same R&D project can either make administration more efficient for the user (if funding agencies are consistent in their reporting requests) or create extra administration (with lack of consistency).

The survey result that most SkatteFUNN projects are development projects is confirmed by the R&D statistics. Table 6.1 shows descriptive statistics on firms who reported their development, applied research and basic research cost shares in the R&D survey, a question that was asked biannually. Between 20 and 30 percent of firms with main support from SkatteFUNN report this for the years 2003 – 2015.

Figure 6.1 Type of R&D conducted in latest SkatteFUNN project. N=581.



Source: Technopolis web survey

Table 6.1 Development, applied research and basic research cost shares in firms with main support from SkatteFUNN. Percentages weighted by internal R&D cost share. 2003-2015, biannually.

Year	Development cost share	Applied research cost share	Basic research cost share	No. of firms	Average no. of employees
2003	78,8	18,2	2,9	605	120
2005	73,6	22,3	4,0	594	103
2007	78,9	19,0	2,2	487	101
2009	78,2	17,6	4,2	466	109
2011	83,6	13,1	3,4	493	82
2013	79,1	17,5	3,4	555	84
2015	81,2	15,9	2,9	867	94

Only reported biannually in the survey
The statistics are weighted by internal R&D costs over sum R&D costs in firms with SkatteFUNN as main support before we take averages
Source: R&D survey, Statistics Norway

Firms who reported on their R&D type costs shares and have SkatteFUNN as their main public support have a development cost share of about 80 percent on average over the last 8 years. However, some of these firms also have support from RCN, and these cost shares are therefore likely to be biased in the direction of research. However, we have data from RCN, who classify SkatteFUNN projects as either development or research projects. Here, we find that about 85 percent of SkatteFUNN projects are development projects. The share of development projects varies between 80 and 90 percent over the period 2002-2016.

6.2 The majority of projects lead to innovations

Successful R&D projects lead to innovations. SkatteFUNN recipients report on results of their projects to the Research Council. In these data, we find that the median number of innovations attained per project is 1. Indeed, 62 percent of all SkatteFUNN projects have resulted in one or more innovations. The median is also 1 for process innovations, and this type of innovations was achieved in about 27 percent of all initiated projects. Missing observations on innovations account for the low share of process innovations, but missing observations are also present for other innovations in projects. Ignoring missing observations, the share of projects with one or more innovations is 84 percent and the share of projects with one or more process innovation is also 84 percent.

Table 6.2 Shares of firms with innovations, divided into three types of innovations and within groups of firms by main support; IN, RCN or SkatteFUNN. 2004-2014, biannually reported for a three-year period.

	Firms with main support from IN			Firms with main support from RCN			Firms with main support from SkatteFUNN		
Year	Share of firms with product innovations	Share of firms with innovations new to market	Share of firms with process innovations	Share of firms with product innovations	Share of firms with innovations new to market	Share of firms with process innovations	Share of firms with product innovations	Share of firms with innovations new to market	Share of firms with process innovations
2004	8 %	5 %	5 %	25 %	14 %	16 %	22 %	12 %	15 %
2006	14 %	9 %	13 %	14 %	8 %	12 %	23 %	15 %	17 %
2008	10 %	7 %	7 %	18 %	13 %	15 %	24 %	14 %	17 %
2010	8 %	5 %	5 %	18 %	15 %	13 %	26 %	22 %	16 %
2012	7 %	5 %	6 %	15 %	13 %	12 %	22 %	20 %	14 %
2014	9 %	7 %	8 %	25 %	20 %	20 %	26 %	20 %	18 %

Only reported biannually in the survey
Source: Innovation survey, Statistics Norway

6.3 The same share of innovations new to market as R&D projects supported by RCN

In table 6.2, we show the shares of firms with innovations, divided into three types of innovations and within groups of firms by main support; IN, RCN or SkatteFUNN. These show a different picture of the innovation share among SkatteFUNN recipients. The data indicate that SkatteFUNN projects have the same possibility to be new to the market as projects supported by RCN in general. For both, the possibility is higher than projects supported by IN.

However, it is important to be aware of potential problems these data. One problem is how we define main support. Some firms have more than one source of public funding, which means we in some cases classify project results to the wrong funding agency. Another issue is the fact that the R&D and Innovation surveys only sample the population among firms with 50 or less employees. This leads to a bias in the data, since there is an overweight of large firms in the sample, compared to that of the population. Also, since the SkatteFUNN user group consists of a higher share of SME's than the RCN user group, this leads to a bias in the data. Our interpretation is that the data bias rather leads to underestimation than overestimation of the share of SkatteFUNN innovations that are new to market.

6.4 14 percent of projects achieve one or more patents

The result of a R&D project can be protected in terms of secrecy or be officially registered as a firm patent, design or trademark. In terms of patent applications, firms with main support from SkatteFUNN have a lower share of patent applications per firm with one or more patent applications than firms with main support from RCN, but a slightly higher

Table 6.3 Share of firms with one or more patent, design and trademark applications within groups of firms by main support; IN, RCN or SkatteFUNN. 2002-2015.

	Main support: SkatteFUNN		Main support: RCN		Main support: IN		Firms with no support	
Year	Share of firms with one or more patent applications	Share of firms with one or more design applications	Share of firms with one or more patent applications	Share of firms with one or more design applications	Share of firms with one or more patent applications	Share of firms with one or more design applications	Share of firms with one or more patent applications	Share of firms with one or more design applications
2002	4,7 %	0,6 %	10,3 %	0,0 %	2,9 %	0,1 %	5,4 %	1,1 %
2003	4,4 %	0,7 %	7,5 %	1,0 %	2,7 %	0,3 %	2,1 %	0,7 %
2004	4,3 %	0,8 %	9,6 %	0,5 %	3,6 %	0,8 %	1,3 %	0,8 %
2005	4,3 %	0,9 %	8,3 %	1,3 %	2,6 %	1,0 %	2,8 %	1,2 %
2006	4,3 %	0,7 %	7,3 %	0,2 %	2,5 %	0,7 %	2,7 %	0,5 %
2007	5,3 %	1,0 %	6,9 %	0,7 %	2,3 %	0,6 %	2,3 %	0,9 %
2008	5,4 %	0,6 %	7,3 %	0,5 %	3,1 %	0,7 %	2,1 %	0,5 %
2009	5,5 %	0,8 %	5,4 %	1,3 %	3,5 %	0,6 %	2,2 %	0,4 %
2010	5,0 %	0,7 %	5,9 %	1,1 %	2,7 %	0,6 %	1,8 %	1,0 %
2011	4,2 %	0,9 %	4,6 %	0,8 %	4,0 %	0,5 %	2,5 %	1,1 %
2012	4	0,8 %	4,5 %	0,9 %	2,7 %	0,7 %	1,5 %	0,9 %
2013	3,8 %	0,9 %	5,5 %	1,0 %	2,6 %	0,6 %	1,5 %	0,5 %
2014	3,9 %	0,9 %	3,4 %	0,7 %	2,6 %	1,2 %	1,3 %	0,4 %
2015	3,9 %	1,0 %	3,7 %	1,1 %	2,6 %	0,8 %	0,3 %	0,3 %

Source: Norwegian industrial property office

share than firms with main support from Innovation Norway.

We see the same picture for design applications. Tables 6.3 and 6.4 show statistics on patent and design applications. Note that the abovementioned data issue pertaining to our classification of firms by funding agency is relevant here as well.

We only have data on trademark applications for 2013, 2014 and 2015. For these years, firms with main support from RCN also have a higher share of applications per firm with one or more applications, than that of firms with main support from SkatteFUNN, Innovation Norway and those with no support. However, among the latter three, firms with no support have a higher share than SkatteFUNN and IN firms.

Of all initiated projects in the SkatteFUNN project data we have from the Research Council (RCN), about 14 percent of projects achieve one or more patents. If we ignore missing observations in the recipients' reporting of results, the share is 40 percent.

Table 6.4 No. of patent, design and trademark applications as share of firms with one or more patent applications within groups of firms by main support; IN, RCN or SkatteFUNN. 2002-2015.

	Main support: SkatteFUNN		Main support: RCN		Main support: IN		Firms with no support	
Year	No. of patent applications as share of firms with one or more patent applications	No. of design applications as share of firms with one or more design applications	No. of patent applications as share of firms with one or more patent applications	No. of design applications as share of firms with one or more design applications	No. of patent applications as share of firms with one or more patent applications	No. of design applications as share of firms with one or more design applications	No. of patent applications as share of firms with one or more patent applications	No. of design applications as share of firms with one or more design applications
2002	1,45	1	1,81		1,77	1	2,8	2,5
2003	1,64	1,16	1,6	1	1,21	1,33	3,92	1,75
2004	1,79	1,19	3,78	1	1,32	1,3	3,25	2,4
2005	1,73	1,2	2,24	1	1,5	1,5	1,84	1,5
2006	2,03	1,06	2,27	1	1,75	1,73	1,81	2
2007	2,12	1,1	3,35	2	1,31	1,09	1,53	1,57
2008	1,86	1,1	2,4	2,33	1,31	1,11	1,78	2,25
2009	1,70	1,23	3,83	1,89	1,52	1,2	1,5	1
2010	1,89	1,79	2,91	1,78	1,29	1,2	1,56	1,22
2011	1,66	1,29	3,26	1,57	1,45	1	1,75	1,11
2012	1,63	1,29	3,37	1,25	1,29	1,27	1,57	1,25
2013	2,17	1,38	2,82	1,22	1,51	1,09	1,33	1
2014	1,71	1,26	3,43	1,86	1,4	1,68	1,6	1,33
2015	1,66	1,31	3,53	1,09	1,94	1,21	2,5	1,5

Source: Norwegian industrial property office

7 SkatteFUNN and alternative measures

A major advantage of SkatteFUNN, compared to many other national schemes, is its low administrative costs. That SkatteFUNN is available to all, without a time consuming and costly application process for the authorities as well as firms. The process involving application for R&D schemes is often especially a barrier for SMEs with little or no experience with these processes. A convincing majority of firms in our survey were positive to SkatteFUNN's application and reporting process. We also find that the relative low administration cost does not imply that SkatteFUNN has lower additionality than other schemes. By comparing our results with the results of studies on the additionality of R&D subsidies we conclude that SkatteFUNN's additionality is higher.

SkatteFUNN entitles all firms the right to tax deductions for R&D expenses, provided that their project aims at creating new knowledge or new experiences in association with development or improvement of goods, services or processes. That fulfilment of set criteria provides firms with the right to receive a tax deduction makes SkatteFUNN different from most other R&D supporting schemes. In NOU 2000: 7, the green paper that laid the foundation for SkatteFUNN, the Hervik committee underlined the importance to create a scheme to give firms right to R&D support based on objective criteria. The argument was that a rights-based scheme with a simple approval process would make it easier for each individual firm to plan its R&D efforts. This was supposed to be especially important for SMEs.

In this chapter we discuss to what extent the SkatteFUNN-users actually see this as an important feature of the scheme. We do also discuss this feature's impact on the impact of SkatteFUNN and the consequence of changing SkatteFUNN to an application-based scheme.

7.1 How does SkatteFUNN differ from other R&D enhancing schemes?

An immediate advantage of a rights-based scheme, compared to an application-based schemes, is that it provides low administrative costs for both applicant and application processor. Only the terms of support are up for consideration. This will clearly reduce time consuming and costly application processes.

The right to support also move the ultimate decision of what the R&D activity should consist of from policy makers to the market. From the firm's perspective a right to support will make it make it easier to link the R&D decision to the firm's strategic interests.

The cost of moving the decision of R&D activities to the firms is that it make it difficult to develop a long-term policy for strategic knowledge building in the society. That's why the Hervik committee narrowed the proposal for SkatteFUNN to smaller R&D projects. Support for larger R&D projects in firms was left to traditional direct support schemes administrated by the RCN.

It is not obvious that the government has an information advantage as to which projects will succeed or potentially bring highest social (Hall and Van Reenen, 2000). But it is more legitimate to emphasize national research strategic considerations when it comes to support larger projects. In this way, SkatteFUNN contributes to balancing the importance of low administrative costs in supporting R&D in firms and national research policy considerations within a single system of public support for private R&D.

7.2 Our survey of recipients indicates few barriers to use SkatteFUNN

As part of the survey of SkatteFUNN recipients done in this evaluation, we have asked how the recipients experience the practice of the scheme compared to other schemes for support for R&D. A convincing majority of firms were positive regarding the application and reporting process.

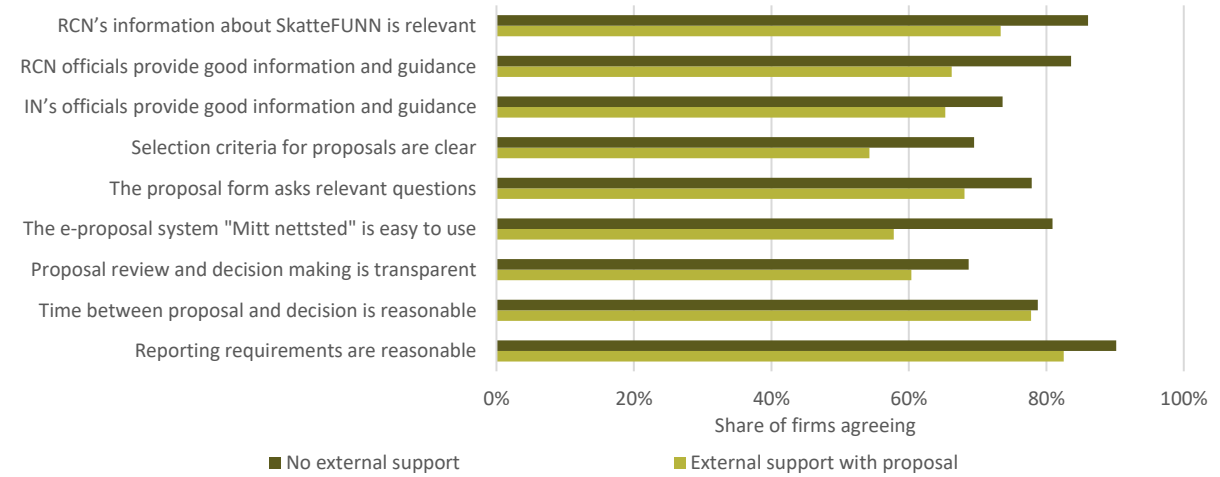
Most firms were also satisfied with the information and guidance provided by both the Research Council of Norway (RCN) and Innovation Norway (IN) officials about the scheme, but RCN officials received slightly more positive assessments (77 percent agree that RCN officials are helpful, compared to 71 percent for IN).

A majority of firms also expressed satisfaction with the selection criteria. Only 9 percent disagreed with the statement that the criteria are clear, whereas 63 percent agreed, cf. Figure 7.1. However, respondents that were interviewed as well expressed that most of the criteria were intelligible, but that the main difficulties were understanding the definition of R&D and eligible costs.

The firms' auditors seem to have a key role in the application and reporting process, acting as both adviser, when preparing and planning an application, and control mechanism, when reviewing project costs. According to interviewed RCN officials, the RCN collaborates with national auditing organisations to develop guidelines and information on how to audit SkatteFUNN projects, and has established workshops for firms that seek advice on how to prepare a proposal.

The greatest difference on the issue of SkatteFUNN administration was between firms that enlisted a consultant in the applying process, and those who managed on their own application. The latter group was consistently more satisfied with the available information and guidance, as well as the proposal and reporting processes, as illustrated in Figure 7.1. We know from the interviews that consultants who assist firms in proposal preparation may also handle project reporting, thus relieving the firm of most of the project administration. Consequently, firms that enlisted consultants for proposal preparation in general get less experience with SkatteFUNN administration, and thus find it more difficult to understand. We also noted above that most of these firms had no prior R&D experience.

Figure 7.1 Firm's view on SkatteFUNN administration. N=566.



Source: Technopolis web survey

The lower satisfaction among firms who outsourced parts (or all) of the project administration can be interpreted in several ways.

One possibility is that firms with little experience of applying for public funding are still sufficiently familiar with the requirements to find them demanding, which could explain why they choose to enlist external assistance.

Another interpretation is that firms do not examine the requirements in detail and assume that proposal production will be cumbersome and time consuming, which also rationalises the use of consultants. Interview statements support both interpretations, and we noted above that use of consultants does not decrease with the number of SkatteFUNN projects. Either way, these firms will at best only slowly learn how to produce a proposal (interpreting requirements, transforming an idea into a proposal and a project plan etc.), making them less equipped to apply for other public grants on their own.

There seems to be few barriers for firms to use SkatteFUNN to the extent they wish. Both in interviews and free-text comments made by survey respondents, the overwhelming picture that emerges is that users are quite satisfied with the way in which SkatteFUNN is set up and functions.

The cost ceiling was increased in 2009, 2014 and 2015, but most SkatteFUNN users are too small to come near the cost ceiling, and are in practice left unaffected by such changes.

The most important barrier raised by small firms is the delay between when the costs are incurred and when support is received, which can create liquidity problems. Another barrier mentioned is that the administrative burden is not proportional to the financial yield. Inexperienced users of public R&D funding are in general experiencing larger administrative challenges compared to others.

Although there are some complaints about administration being too complicated or cumbersome, we have received very few suggestions on how to make SkatteFUNN more accessible or user-friendly; instead most interviewees recognise that there must be a certain level of control (which inevitably leads to administration for the user) to prevent misuse of public funds. According to interviewed RCN officials, the Council has devoted a lot of attention to lowering the thresholds for firms to use SkatteFUNN, primarily by streamlining the proposal process and making it more transparent and producing more unanimous decisions.

7.3 More than 70 percent of firms rated SkatteFUNN as most easy to apply for

More than 70 percent of firms rated SkatteFUNN as easier to apply for and as having more reasonable reporting requirements rather than other R&D co-funding opportunities, and 20 percent believed that IN offers an easier proposal process.

SkatteFUNN was preferred by 83 percent of firms for its high rate of project approval, and SkatteFUNN was considered the measure most well-adapted to firm needs and working practices (70 percent prefer SkatteFUNN in that regard).

SkatteFUNN was also considered to offer an appropriate leverage of firms' own investment according to 53 percent of firms, while 31 percent prefer RCN measures and 25 percent IN measures in this regard. Full set of survey results on how SkatteFUNN is viewed compared to other measures can be studied in Appendix A.

7.4 Most users write their own application

A clear majority of firms wrote the SkatteFUNN application on their own, while third part of firms used a consultant (that did not participate in the project later). Three percent of firms used an R&D institution that later became a partner in the project. This is in line with the results in RCN's annual user survey, which suggests that the share who use external assistance has decreased in the last three years.[67] Figure 7.2 clearly illustrates that the need for external assistance decreases with R&D maturity. In this respect there are no notable differences between firms of different size or sector.

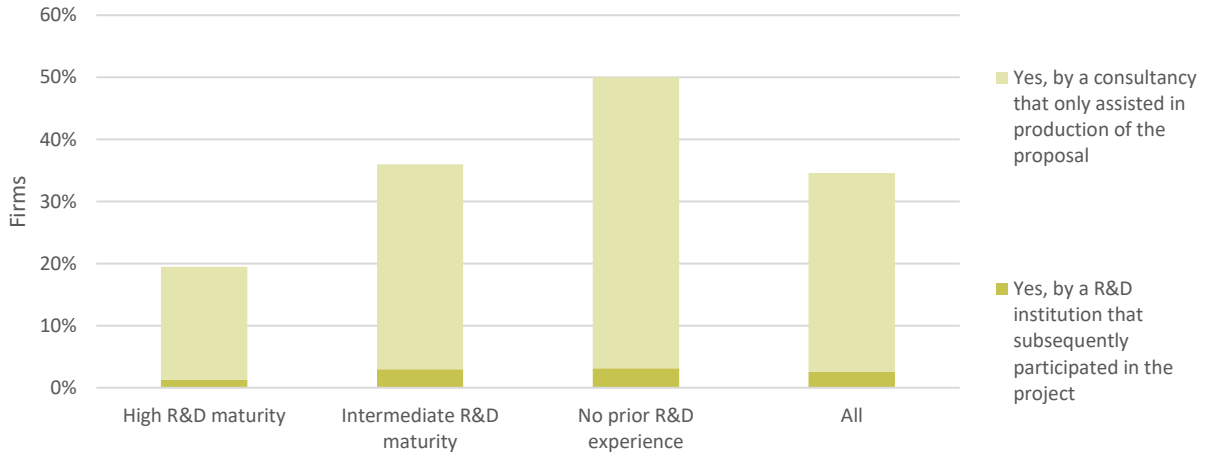
The number of SkatteFUNN projects does not seem to reduce the need for assistance with applications, see Appendix A for detailed results. This observation suggests a path dependency, where firms that got assistance for their first application continues to do so.

Interviews with firms taking advantage of hiring consultants reveal that some of these firms get detached from most of the interaction with the SkatteFUNN administration. A possible interpretation is that the threshold experienced by first-time users is not reduced through subsequent application experiences. Only firms that have completed six or more projects are notably less likely to enlist external assistance (72 percent, compared to an average of 63 percent among those with fewer than six projects).

Moreover, the higher degree of R&D maturity of these firms is likely more important in this respect than the experience of many SkatteFUNN projects. From interviews we learn that most firms that have used external assistance do so because they perceive the application process as complicated, to reduce the risk of having their proposal rejected, or for convenience.

Since SkatteFUNN has size and funding-level limits, RCN measures were preferred by 44 percent of firms, IN measures by 39 percent, and Horizon 2020 by 22 percent when project dictate a larger budget or a higher level of support.

Figure 7.2 Was the firm assisted in writing the latest SkatteFUNN proposal? N=587.



Source: Technopolis web survey

[67] "Undersøkelse om SkatteFUNN 2017", RCN, 2017.

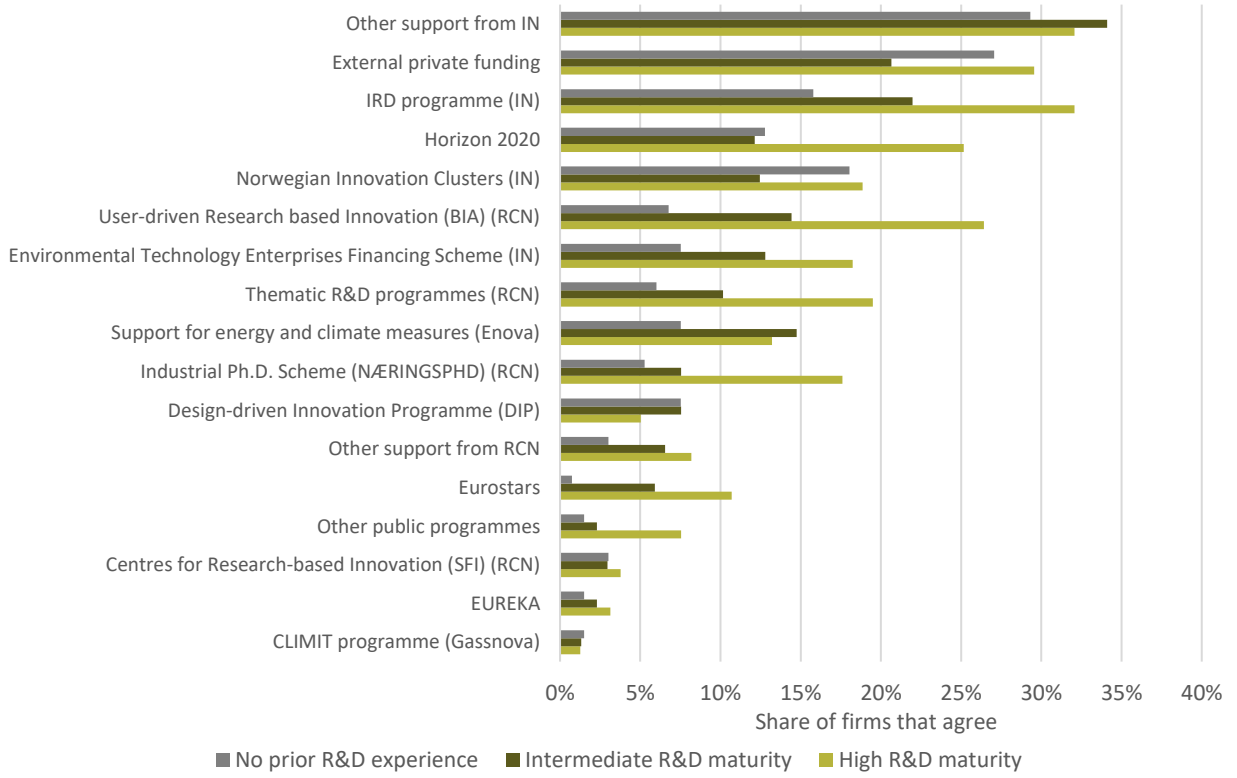
7.5 Firms accredit SkatteFUNN for its co-funding opportunities

Close to 90 percent of firms' state that they have recommended SkatteFUNN to other firms and virtually all firms (98 percent) rated SkatteFUNN as the most relevant co-funding measure for their current and future R&D needs. Their rating of other funding opportunities is shown in Figure 7.3.

Besides SkatteFUNN, the measure relevant to most firms was the generic "other support from IN", despite our effort to provide respondents with a comprehensive list of frequently exploited opportunities. The third most preferred opportunity was external private funding, followed by IN's Innovation Cluster and IRD programmes, where SMEs can apply for funding to conduct projects for product and service development in collaboration with Norwegian or foreign pilot customers or government entities.

For several measures, the difference is quite substantial between firms with no prior R&D experience and firms with intermediate or high R&D maturity. For inexperienced firms, IN's different measures were perceived as most relevant, but these were followed (to our surprise) by Horizon 2020, rated as potentially relevant by 10 percent. RCN's User-driven Research based Innovation programme (BIA) and its thematic R&D programmes were identified as relevant by 7 and 6 percent of inexperienced firms, respectively.

Figure 7.3 Firm's view on other relevant R&D co-funding opportunities. Alternatives sorted by average order of descending agreement. N=564.



Source: Technopolis web survey

Firms with high or intermediate R&D maturity held IN's IRD programme as the third most relevant support measure. BIA, Horizon 2020, RCN's thematic R&D programmes and Industrial PhD scheme; and IN's Environmental Technology Enterprises Financing Scheme were all rated as potentially relevant opportunities by at least 15 percent of firms with high R&D maturity.

Centres for Research-based Innovation (SFI), EUREKA and Gassnova's CLIMIT Demo programme only attracted small shares of SkatteFUNN firms (less than 5 percent). SFI and CLIMIT Demo mainly attract larger firms that do not use SkatteFUNN to the same extent as SMEs.

7.6 SkatteFUNN probably enhance more R&D per krone, than comparable schemes

The user assessments made visible through the survey and interviews mentioned above clearly indicate that SkatteFUNN has lower administration costs than other schemes supporting research or innovation in the business sector. It is therefore interesting to compare if the relative low administration cost is offset by higher result effects from other schemes. Analyses' of input additionality of different schemes do not indicate this, rather it's the contrary.

As described in chapter 4, we find that each krone in forgone tax revenues due to tax credits induced private R&D to increase by 2.07 kroner. We have not estimated the input additionality of other R&D enhancing schemes, as this was not included our mandate.

However, Henningsen, Hægeland and Møen (2012) estimated the input additionality of R&D subsidies. In their analysis they conclude that the input additionality is 1.15.

Even though we have a somewhat lower estimate on input additionality, compared to Hægeland and Møen (2007) were they concluded that each krone on tax credits spent induced private R&D to increase by 2.68 krone, it is interesting to note that input additionality for direct R&D subsidies was estimated lower than for SkatteFUNN.

8 Misuse of SkatteFUNN

We have analysed the potential for misuse of SkatteFUNN based on selected indicators in collaboration with the Tax Administration. We have found examples of what can be interpreted as tax motivated misuse of the scheme, but have no reason to believe that it is extensive, although it is impossible to quantify due to lack of data (note that we are expecting data from the Tax administration during the spring, hopefully in time for the final report). To some extent, however, one must accept misuse as a cost to support schemes intending to attract many firms. This is particularly so when, as is the case with SkatteFUNN, control routines and administrative expenditures are kept at a low level.

A continuing concern related to R&D tax incentives is the possibility for tax evasion or avoidance. Tax evasion and other misuse of public schemes will always be a loss to society and tax payers. In addition to the societal costs of tax avoidance in general, abuse of SkatteFUNN may result in a loss of legitimacy of the scheme. In the case of SkatteFUNN misuse typically would involve reporting accrued costs related to ordinary operations as R&D costs or inflating R&D costs. Being a general tax credit scheme, there is no overall aggregate ceiling for the scope of forgone tax revenue for the state, nor is there any competition between firms ensuring that the funds are awarded to the best R&D projects.

Misuse of SkatteFUNN has taken place. However, one must expect that grants or other support schemes aiming to be used by many actors, will be illegally exploited to some extent. This is especially true if you want to keep administrative costs and control routines at a low level, which is the case with SkatteFUNN. Although some misuse takes place, little is known about how wide- spread abuse is.

Finding the right balance between user-friendliness and low administrative costs for firms and government on the one hand, and the prevention of fraud and misuse on the other is no trivial challenge. According to Uhlíř, Straathof and Hambro (2017) the tax incentive schemes have generally been expanding, both because more firms use them and because they have become more generous. Meanwhile, the governmental administrative resources have remained the same. This amplifies the challenge to strike the right balance. This is definitely an issue for SkatteFUNN, which is easier to administer than most similar schemes in other countries, and hence has relatively low administrative costs. To land a reasonable trade-off between the cost of using more resources on application processing and control and the cost of supporting firms abusing the scheme, the extent of abuse must be assessed. For the legitimacy and impact of the scheme it is important that the misuse is not too large. This is also important when quantifying the desired effects of SkatteFUNN. If misuse results in a much higher registered level of R&D than what is actually taking place, our evaluation will be at risk of overestimating the additional R&D investments caused by SkatteFUNN, potentially hampering the evaluation.

Besides from being central to rule out potential overestimation, the purpose of this chapter is to investigate the potential loss in revenue experienced by the state due to the misuse of SkatteFUNN. In 2016, the forgone tax revenue due to SkatteFUNN was about NOK 3,5 billion. Of this, around 70 percent is given to the firms as a direct grant.

It is therefore central that the extent of misuse is analysed. It further calls for a consideration of how any misuse of SkatteFUNN may affect the analysis of the scheme's effects (e.g. in that misuse affects the data used in the analysis), including how this issue can best be countered in the analysis.

We have analysed the potential for misusing SkatteFUNN (either illegally or as an unwanted adaptation

of firms' activity) based on selected indicators in collaboration with the Tax Administration. We also put forward recommendations as to how misuse can be limited and how authorities can conduct controls in an efficient manner. The results given in this chapter are utilized to adjust the impact evaluation of the scheme.

8.1 Different forms of misuse

As the tax incentives vary from one country to another, the prioritization of which elements in an application or scheme should be addressed for preventive purposes or control, must be looked at in a national context.

When establishing preventive measures or controlling applications or claims it is useful to take into consideration how abuse may take place, and to which of the possibilities of misuse should be given most attention.

Tax adjustments are not always illegal, nor do they necessarily have to be large enough to be classified as misuse of the scheme. In our context, misuse of the scheme is defined as activities conducted by a firm to increase public funding through SkatteFUNN, which is not related to increased R&D efforts. These activities may include situations where firms unjustified claims SkatteFUNN or fails to provide full disclosure, it can either be conscious or by negligence.[68]

To further investigate the possible misuse of SkatteFUNN it is fruitful to theoretically present potential ways of misusing the scheme, within the context of how SkatteFUNN is administered. Through dialog with the Tax administration, we have concluded that the following probably are the most common forms of misuse:

- Incorrectly presenting costs that have not been incurred for the purpose of R&D, but for other purposes
- Inflating the costs
- Presenting something as R&D which is not, or is only in part R&D

Claiming a tax deduction related to equipment that may not be necessary for the performance of the R&D project is an example of presenting cost outlays for other purposes as eligible. Inflating the costs can for example be done by claiming for more hours of manpower or machine time than has been used.

Furthermore, a relatively common general issue, that also is relevant in the case of SkatteFUNN, is exaggerated internal pricing (for work performed, equipment leased, or the use of intellectual property used in the project) within a corporate group in order to minimize the global tax burden for the group. Such practice in the case of R&D would further benefit the firm as it would inflate the cost base for claiming the tax credit.

In principle the scheme could be misused by falsely presenting a project as R&D, whereas the truth is that the project does not meet the R&D definition in the SkatteFUNN-regulation. This could for example be the case where the R&D actually is carried out for the benefit of another firm in the corporate group.[69] However, the fact that RCN reviews all project descriptions ex-ante, probably makes this type of misuse unattractive, because the risk of being caught is rather high. The RCN might by mistake re-

[68] With this definition misuse does not include the situation where a tax deduction is rejected on a formal basis (e.g. due to lack of auditor's attestation) or due to misinterpretation of the regulations (e.g., claims made by an institution that is not taxable).

[69] The R&D-definition requires that the firm intends to use the R&D results in its own activities. Contract research falls outside the R&D definition

ject a project that is not really R&D or approve a project that, in reality, does not meet the requirements for R&D. This would, however, not be misuse of the scheme, but management error.

We will focus on these main categories of misuse. There are, however, several other possibilities for misusing the scheme. Examples here could be not reporting direct grants that in part should lead to a reduction in the tax credit, or by neglecting to deduct the sale of a prototype from the eligible cost.[70]

8.2 Control approaches

Different countries have different approaches for hindering misuse of their R&D tax incentives. The approaches can broadly be divided into 1) those related to evaluating the applications for tax credit and 2) those related to controlling the compliance of firms whose application is accepted.

8.2.1 Control of the applications

In SkatteFUNN, all the R&D projects are assessed on an ex-ante basis in relation to the question of R&D content and which activities may be regarded as part of the R&D project. Ex-ante decisions give firms more certainty and predictability than ex-post decisions. A compulsory ex-ante review implies that whether the R&D requirement is fulfilled, is checked for all project applications. This characteristic is highly important for the potential to misuse the scheme, as it makes it difficult to claim tax deductions for costs related to activities that are not presented in the project plan.

This is not the case for similar schemes in all countries. In Portugal for example all R&D projects are checked ex-post for compliance with the R&D definition and the tax authority receives a confirmation of the total eligible cost or a proposal for correcting the claim from ANI (National Innovation Agency). Ex-post rulings are based on what has taken place, and not what was planned. Therefore, ex-post evaluation of applications might be less burdensome from an administrative point of view, both for the firm and for the public authorities (Uhlíř, Straathof, & Hambro, 2017).

Applying a given R&D definition ex-ante or ex-post is in theory the same, assessing whether the facts meet the elements in the definition. In practice, the relationship between industry and tax authorities could differ in the two situations. In ex-ante schemes, a dialogue can take place with adjustments to the R&D project and the wording used to explain the project. If approval is not given, the firm can choose not to run the project. In the ex-post schemes, the firm has already spent its money and the issue of approval is critical to the question of how much of the costs the firm must pay itself. This might induce the tax authorities to be lenient when applying the R&D definition, or might result in conflicts that lead to appeals.

In Canada, that uses more resources than most countries in guiding firms to claim the tax credit correctly and evaluate compliance, approximately CAD 400 million is reclaimed annually as non-compliant expenditures (Uhlíř, Straathof, & Hambro, 2017). Canada assess each firm's technical and financial eligibility. Canadian authorities invest in both detecting and deterring non-compliance. These activities and controls successfully identify and protect important amounts of tax credits each year.

8.2.2 Control of compliance

Controlling beneficiaries' compliance could be based on a risk assessment or random selection. A risk assessment could consist of several elements

[70] SkatteFUNN can be combined with direct grants, if the amount of aid does not exceed the permitted level of support under the EU Tax Exemption Regulation 651/2014.

that either alone, or in combination with other factors, exceed a certain threshold of risk judged as critical. The forms of misuse that is most widespread or imply the most risk for economic losses for the state depend on several factors, such as firm size, group relationship, ownership and industry. For the tax authorities it is most relevant, due to cost efficiency, to select a risk-based approach to assess which firms should be checked more thoroughly. For statistical purposes however, such an approach would not give results that are representative for all firms, but would give the impression of more misuse than what generally is the case. Random tests are most useful to quantify the level of misuse.

In the UK, a risk based assessment system is established that takes into consideration several features that typically affect tax claims, and have been associated with high risk of misuse. This includes for example criteria based on project size and changes in claim characteristics. The system utilizes profiling techniques to select high risk claims for further investigation. A risk which is highlighted by HM Revenue and Customs (HMRC) is when tax credits for costs related to external R&D personnel are claimed. Canada also uses a computerized risk-assessment system for initial screening of claims to ensure that the claims at highest risk for non-compliance are detected and subject to the verification activities (Uhlíř, Straathof, & Hambro, 2017).

Although controls based on random selection is useful in estimating the scope of misuse, this approach is rarely used in practice. One exemption is France, where a sample of firms is controlled each year (between 7 and 8 percent). The result of this control activity is recuperation of about 280 million euro (Uhlíř, Straathof, & Hambro, 2017).

There has not been a consistent strategy for control of SkatteFUNN recipients. When applying for SkatteFUNN, this must be done in a form specifying cost types and that is certified by an auditor. In addition, the firm is obliged to have separate project accounts including hours worked on the project per employee and the hourly cost for each employee. These accounts are to be kept on a continuous basis. A prudent auditor would require all employees working on the project to confirm their project engagement.

A significant issue for the Tax administration when controlling SkatteFUNN recipients has been a lack of resources in assessing whether the activities in the project are in line with the description sent to RCN. The Tax administration lack the competence to assess whether the actions classify as R&D in accordance with the regulations. Furthermore, it is difficult to assess whether the discrepancies found during controls are related to deliberate misuse or sloppiness. The Tax Administration is concerned that there is an established culture in which one does not have sufficient respect for the regulatory requirements. There are for example several tax deduction claims lacking the auditors signature.

To improve the efficiency of the control activity, the RCN and the tax administration entered into an agreement in 2016. The objective is to enhance collaboration between the two, to make it easier to reveal and sanction misuse.

8.3 Empirical indicators of misuse

Estimating the scope of misuse is very difficult, both methodological and when it comes to obtaining relevant data. For example, the option of cash refund on R&D expenses may incentivise claimants to inflate the reported R&D-costs. But without access to sufficient data, it is not possible to assess to which degree this occurs. We have therefore chosen to analyse the problem through several approaches, to see if results point in the same direction.

Finding suitable indicators of misuse is challenging for several reasons. For example, one might think that comparing firms' claimed R&D costs in the application, with those reported in their financial statements, could be an indicator. If the claimed R&D costs were to exceed the costs of R&D in the firm´s accounts, this could be an indication of misuse. However, there is no requirement to specify R&D in financial statements.[71] Although notes on R&D costs are to be included in the statements of large firms, most SkatteFUNN firms are small.[72] Hence, such an approach would fail to include relevant parts of the population of firms. In addition, a mismatch between financial statements and SkatteFUNN applications need not be evidence of misuse. It may reflect a failure to fulfil the requirement for presenting notes in the accounts.

Another option is to compare SkatteFUNN statistics with R&D statistics.[73] If a firm claims to have had higher R&D costs when applying for the tax than what it has reported in the R&D statistics, this could be an indication of misuse. However, this is also a weak indicator. Firstly, a firm knowingly abusing the scheme would probably ensure that there is a correspondence between what is stated in context of SkatteFUNN and what is stated in the report to the R&D statistics. Mismatch between the two statistics may furthermore be due to under-reporting to the R&D statistics and not indicate any misuse. Secondly, the firms included in the R&D statistics rarely have less than 10 employees, whereas a majority of the firms claiming SkatteFUNN are smaller. Thus, the R&D statistics would not cast any light on possible misuse by the small firms

The preliminary conclusion in this chapter is that linking and analysing data sets will hardly be enough to estimate the scope of misuse. However, this does not mean that linking and analysing the data sets are not useful, and it will certainly be beneficial to categorize indicators of misuse. The remainder of this chapter will go through indicators of misuse found in the previous SkatteFUNN-evaluations, found by the Tax administration and by us. In the conclusion, we will suggest ways of ensuring compliance, and which changes to this chapter to be expected before final delivery of this report.

8.3.1 The previous SkatteFUNN-evaluation found indicators of misuse

There have not been any major changes in the administration of SkatteFUNN since the scheme was established, and in principle the rules are the same as before. Previous studies of misuse are therefore still valid to day.

Fjærli (2007) analysed potential misuse of SkatteFUNN by going through project claims. He found that only about half the claims where of sufficient quality. Furthermore, most auditors noted that they found it rather complicated to verify whether the values recorded by firms were true. It became clear, by comparing firms that did and that did not use SkatteFUNN, that firms using SkatteFUNN claimed more R&D expenditure, which indicates that some of this difference could be explained by inflated hours and wages per employee. However, it is important to note that firms who do not use SkatteFUNN, might be indifferent to how the costs are accounted for. Much can be listed as normal operating costs, while

[71] See chapter § 7-14 of the Accounting Act.
[72] Small firms are defined as having less than 50 employees, less than NOK 70 million in revenue and balance of less than NOK 35 million.
[73] The R&D statistics is collected by Statistics Norway. Click here to read more. The survey is a census of all units with at least 50 employees. In addition are all units with10-49 employees and with considerable reported R&D activity in the previous survey included. Among the other units with 10 - 49 employees a random sample is drawn within each stratum (NACE 2-digit and size class). The fraction rate is normally 35 percent, but in some strata 15 and 10 percent are used. The total sample of units is about 4-5000. The sample was extended in the 2006, 2008, 2010, 2012 and 2015 survey to also include firms with 5-9 employees. The total sample of these years is therefore larger than earlier years.

being R&D. In addition, firms using SkatteFUNN are likely to perform more R&D activities than others.

Fjærli (2007) compares timesheets from project accounts with what firms report in the R&D surveys conducted by Statistics Norway. He finds that time recorded per employee in the timesheets is 50 to 100 percent higher than expected based on the firms' characteristics. This could be an indication that the time spent on R&D in tax credit projects is overestimated in the project accounts. However, it could also indicate an underreporting of R&D for statistical purposes. Some firms had extremely high tax deductions, high budgeted R&D costs measured per employee, and unreasonably high personnel costs measured in relation to the firm's actual salary costs. The suspicious numbers seem to be driven by the five to ten per cent of the firms with the most extreme observations. These firms are generally small, typically having less than 10 employees. It is, however, difficult to obtain an accurate picture of the extent of the inflation of R&D costs.

Among firms with only one employee, Fjærli (2007) find examples where the tax deduction and the budgeted R&D costs are high compared to the firm's salary payments. This may indicate that tax adjustments are made through inflated hours, or that the hourly rate of pay used does not correspond with the actual salary. The salary paid is also sometimes very high, despite a low operating profit. Furthermore, the salary appeared lower in similar firms with no R&D tax credit. We have no reasons to believe these findings are not relevant today, although the implementation of a maximum hourly wage and hours spent likely have reduced this issue.[74]

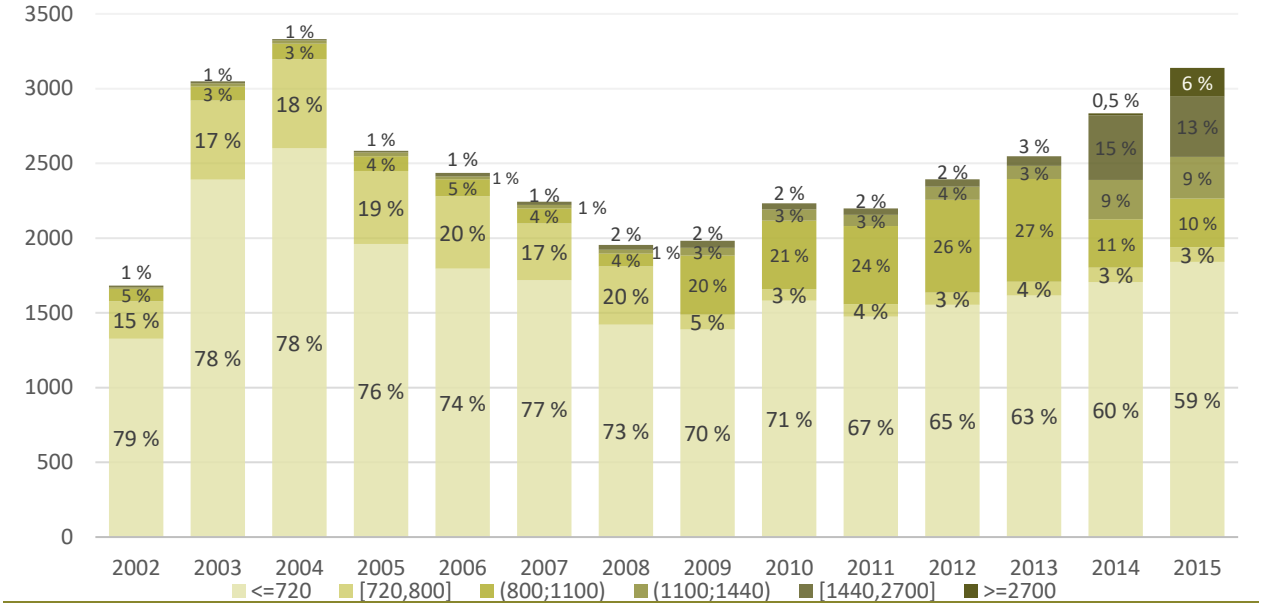
8.3.2 Indicators of misuse from microdata

Figure 8.1 illustrates that an increasing share of firms have got more in tax deduction. When the scheme was first implemented, almost 80 percent of the recipients claimed tax credit for R&D expenses below the ceiling for internally produced R&D, of NOK 4 million. R&D costs of NOK 4 million gave a tax credit of NOK 720 000 or NOK 800 000, depending on whether the firm is large or SME, respectively. In 2015, the share claiming less than NOK 720 000 in tax credit was reduced to about 60 percent of the recipients. The share claiming more than NOK 1.4 million increased sharply in 2014 and the share claiming more than NOK 2.7 million increased in 2015 (the latter implying R&D expenses of more than NOK 15 million). These increases follow from raising the ceiling in the corresponding years. Measured in the scope of tax credit, firms claiming more than NOK 2.7 million accounts for about 25 percent of the forgone tax revenue due to the scheme in 2015. Firms claiming more than NOK 1.4 million accounts for almost 50 percent of the forgone tax revenue.

With an increase in the scheme's generosity through raising the cost ceiling by 525 percent, without a corresponding increase in control activity, the temptation to misuse the system may have grown. An argument against this hypothesis is that the firms that benefit from the higher ceilings in the scheme, tend to be larger. Several forms of misuse are more difficult in larger firms than in smaller ones, and generally auditors would pay more attention in larger firms than in smaller ones

[74] It should be noted that during the first years of SkatteFUNN, many believed that unpaid salaries could be included in the cost base of SkatteFUNN, which could lead to the situation that the accounts showed lower wage costs than presented in the SkatteFUNN-claim. At the time, some obvious cases of abuse were detected along another line, where the owner of the firm presented R&D costs based on an unrealistic high number of R&D hours, and at an extremely high rate. This led to a cap on the number of eligible R&D hours per employee and a cap on the wage cost.

Figure 8.1 The number and share of firms by size of tax credit (NOK 1000)

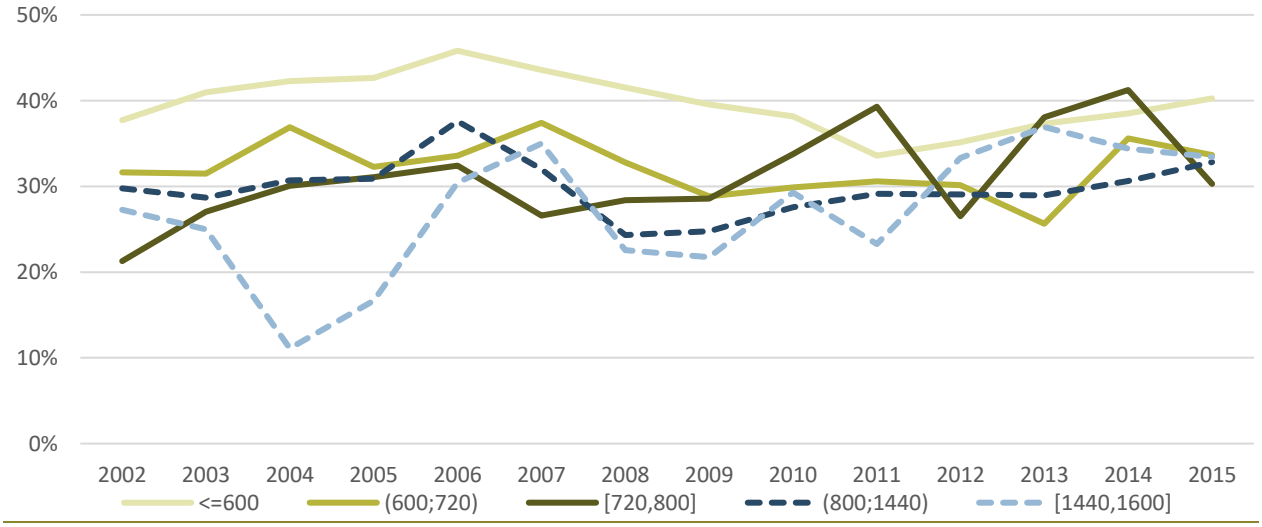


Source: Statistics Norway and Samfunnsøkonomisk analyse

Several forms of misuse are more difficult in larger firms than in smaller ones, and generally auditors would pay more attention in larger firms than in smaller ones.

When looking closer at the recipients of Skatte-FUNN we find that there is a strong positive correlation between claiming large sums for tax credit and not being (fully) tax liable. Figure 8.2 illustrates that the firms with the highest amount of tax credit (above NOK 1.44 million), represented by the blue dotted lines, are also generally the groups with the lowest share of tax liable firms. In total, only 34 percent of the firms were fully tax liable in 2015.

Figure 8.2 The share of tax liable firms by tax credit size (NOK 1000)



Source: Statistics Norway and Samfunnsøkonomisk analyse

It could be a reason for concern that firms that are not (fully) tax liable, on average, have more R&D expenses than other firms. Although, firms in the start-up face are likely to experience losses, and utilise schemes like SkatteFUNN, we did not expect them to have the largest R&D projects.

In addition to granting tax deductions for R&D costs, SkatteFUNN also offers cash payments equivalent to the tax credit to firms that are not in a tax position About 70 percent of the total forgone revenue due to SkatteFUNN was given to firms as cash payment in 2016. This amounts to about NOK 3.5 billion.

The option of receiving cash instead of a tax deduction is identified as a factor that might increase the likelihood of misuse (Økokrim, 2015). It is possible for firms to establish themselves with a sole objective of getting cash from SkatteFUNN, without the

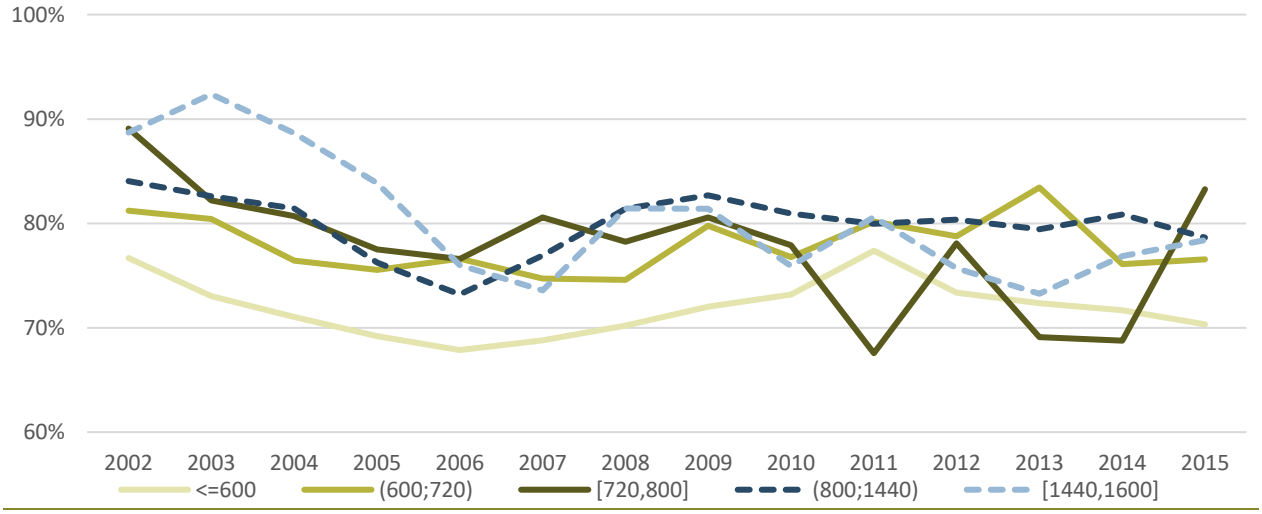
intention to perform R&D. It is not obvious how likely such fraud is, unless the auditor approving the SkatteFUNN-claim participates in the sham, or that a substantial share of claims passes even without an auditor signature (as is shown in Figure 8.6).

Figure 8.3 illustrates that the share of tax deductions paid out in cash, on average, is higher for the group of firms with larger claims. This could be an indication of misuse, as it is possible to establish a firm with the sole objective of getting cash through SkatteFUNN.

Overall, we find that the firms getting the tax deduction in cash are slightly smaller, both measured in employees and revenue, than those who get a deduction on their tax expenses. This is as expected, as firms in tax position would have a running production creating income, and would therefore usually be larger than start-ups.

When analysing the relationship between tax credit, employees, salaries and R&D costs, we find that for smaller firms the tax deduction, which is often paid out as cash, relative to total wage costs is much higher than for larger firms. This relationship is particularly strong for firms with one employee. The average tax credit in such firms covered about 70 percent of the firms' average salary expenses. When comparing to firms with more than 50 employees the average tax credit covers 0,6 percent of the average salary expenses.

Figure 8.3 Share of tax deductions paid out as grants by tax credit size (NOK 1000)



Source: Statistics Norway and Samfunnsøkonomisk analyse

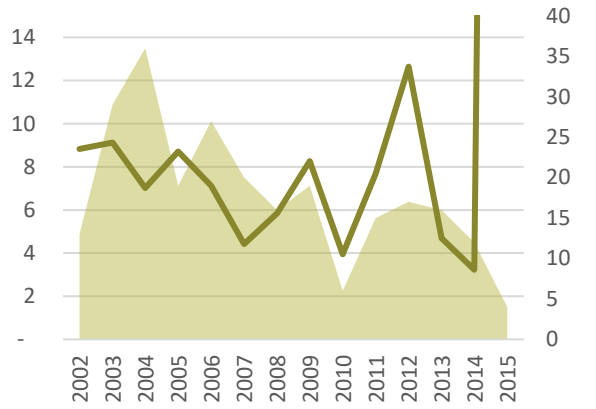
It is however, important to note that SMEs often lack the skills and equipment themselves to carry out their R&D, and must therefore, to a greater degree than larger firms, purchase external resources. Hence, it is to be expected that SMEs' R&D expenses per employee or as a share of wages are higher, than for larger firms. Still, it is reasonable to assume that misuse is easier in SMEs. When there are few employees or only one owner there will be a more direct personal interest in the economy to the firm. It is also more risk associated with misuse in larger firms than in the very small ones, because dealing with illegal activities that employees see is associated with danger while freaking in a small firm without others seeing it is less risky.

For larger firms, however, it is difficult to analyse the relationship between wages and tax deduction, as we do not know how large part of the firm is devoted to the SkatteFUNN-project.

Therefore, we concentrate on firms with only one employee. When we limit the sample to the firms with the 10 percent highest estimated R&D personnel costs, we find that the estimated R&D personnel costs are several times higher than the wage costs of the firm, cf. Figure 8.4.[75] When a firm has higher R&D personnel costs than the actual wage costs it can imply that they purchase R&D services for example from other firms in the same corporate group, collaborate with other firms or that they inflate their own R&D personnel costs.[76] The Tax administration does find in their survey that firms that are active in one or several collaborative projects do sometimes exceed the maximum ceiling for R&D costs.

When purchasing R&D services from others one is not subject to the ceiling for hourly costs and hours spent. This can create an incentive to establish subsidiaries, or purchase R&D services from other firms in the group, in order to circumvent the cap on the number of hours permitted and the cap on hour costs. It is uncertain to which degree this takes place merely to artificially avoid the restriction in the SkatteFUNN-scheme.

Figure 8.4 The median ratio between R&D personnel costs and total wage costs for firms with one employee (left) and the number of firms (right)



Source: Statistics Norway and Samfunnsøkonomisk analyse

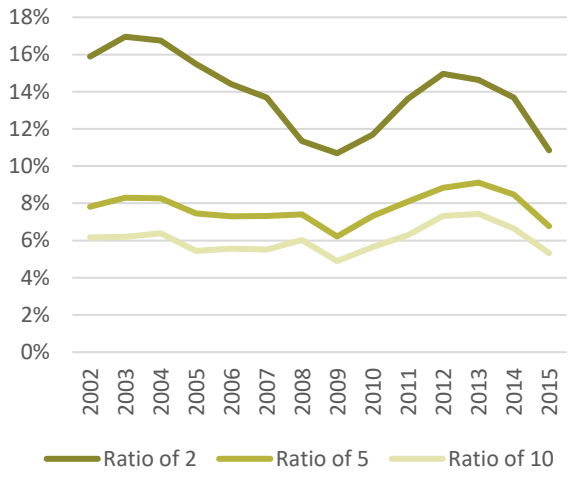
When restricting the sample to firms that have not reported formally to the RCN that they collaborate with other firms, we find that the there is still about 14 percent of the firms benefitting from SkatteFUNN, each year, that have a ratio where the R&D personnel costs are more than twice as high as the reported wage expenses for the firm, cf. Figure 8.5. However, the estimated R&D personnel costs typically accounts for the whole project period, which on average is 2,5 years. Taking this into account, we look at a ratio of more than five instead, and find that the share of SkatteFUNN users with R&D personnel costs at more than five times the firms wage costs

[75] The estimated R&D personnel costs are collected from the RCN database on SkatteFUNN applications. We find that on average, the actual R&D costs end up being slightly less than 8 percent of the estimated R&D costs, on average.

[76] When R&D is purchased from firms that are not approved by the RCN as research institutions the ceiling for R&D expenses is the same as if a firm would perform the R&D itself. See section 16-40 second paragraph letter b.

is on average eight percent for the whole period, cf. Figure 8.5. Furthermore, 90 percent of these firms have less than three employees. When restricting the sample to firms with estimated R&D personnel costs of more than ten times their average wage costs the share is on average 6 percent of SkatteFUNN beneficiaries. We do not find a logical explanation for such high R&D personnel costs, and therefore argue that this could be an indication of misuse.

Figure 8.5 The share of SkatteFUNN users by the ratio of R&D personnel costs and total wage costs



Source: Statistics Norway and Samfunnsøkonomisk analyse

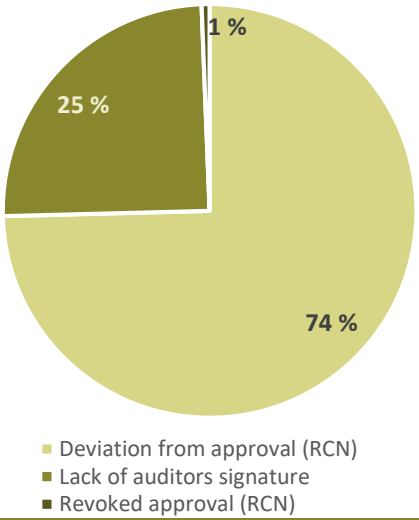
8.3.3 The tax administration finds significant formal lack of compliance

The Tax administration have recently conducted an analysis of 20 randomly selected users of SkatteFUNN with relatively large R&D projects.[77] The main finding was that the required project accounts were not detailed enough. None of the firms had conducted a timetable completely in line with the regulations. It was not possible to utilize the project accounts to conclude whether expenses in fact where related to the R&D project.

If the SkatteFUNN projects are executed as claimed, and the auditor performs his duties in accordance with the principles of good auditing practice, the risk of misuse of the SkatteFUNN scheme will be significantly reduced. However, it seems that the formal requirements in the application and accounts are typically not fully in line with the requirements. The Tax administration have for example been in contract with more than 200 SkatteFUNN recipients because of incorrect filling of their tax credit from (RF-1053). Furthermore, the Tax administration has found more than 500 cases with deviations between reported project or organisational number and the information about approved projects from the RCN. Errors and omissions in the formal requirements does not necessarily mean abuse, but the risk of abuse is greater than when the formal requirements are met.

Figure 8.6 illustrates the share of deviations in claims for tax deduction, by form of deviation.

Figure 8.6 The share of deviations in claims for tax deduction, by form of deviation



Source: Tax administration

[77] The firms where selected randomly, conditioned on them being listed in the south region for the Tax administration and with a tax deduction base of above NOK 10 million.

The Tax administration conclude that the most common forms of misuse discovered in 2017 were related to inflating the costs related to the project or including regular costs as eligible expenses related to the R&D project. The following are explicit findings:

- Firms inflate the hours spent on the project[78]
- Firms record hours of staff who did not work on the R&D project
- Operating expenses are recorded as R&D costs
- Firms claim tax deduction for expenses that are already included in wages as indirect costs
- In collaborative projects, the maximum ceiling is in some cases exceeded
- Firms that participate in several collaborative projects also sometimes exceed the maximum project size per firm

Furthermore, the Tax administration find that there has been an adjustment to the NOK 600 per hour ceiling. The tax administration observes that hours are bought from other firms in a corporate group. There is a significant continuous increase in R&D expenses from purchased R&D from other countries. Økokrim (2015) also expresses concerns related to this increase. Purchasing R&D related goods and services from abroad is not forbidden in any way. However, it does increase the possibility of misuse because it is difficult for the tax authorities to control that the declared costs indeed are eligible.

For the cases that have been addressed by the Tax administration, it seems like a large share of corporate groups utilises designated "single purpose" firms to perform the R&D. The question of whether the R&D is of benefit to the firm is often difficult to answer (§ 16-40-2 (1)). In some of these cases, the group's head office is abroad, and the R&D is purchased from the foreign firm. Another example are cases were the firm uses employees who are abroad, usually in countries outside the EU.

When the R&D is conducted in other countries it becomes more difficult and costly to audit the projects. In particular, determining whether claimed costs are in fact eligible. Furthermore, purchasing R&D from foreign firms can be used to bypass the rules of hourly wage.

The tax administration argues that the reason for the increase in purchasing R&D form foreign firms is the increased ceilings. Due to the increased ceilings firms will have an incentive to increase their R&D costs, and purchasing R&D services from other countries is a way to do that.

8.4 How can compliance be ensured?

At present we lack information that can indicate how widespread the misuse of SkatteFUNN is, and the revenue-loss to the state related to misuse.

However, different ways of misusing SkatteFUNN have been identified. Inspections have confirmed that misuse does occur. A random inspection of 20 (?) firms applying for the tax credit do not fulfil the general accounting requirements for SkatteFUNN and the auditors´ approvals either do not exist, or the auditor has not done his job.

Due to the existing indications of misuse, the non-compliance of the formalities in the scheme, and the magnitude of the scheme, it seems obvious that more controls should be set in place. We suggest that the following measures be considered:

- **Auditors control of R&D project accounts:** When claiming the tax incentive, this must be done in a form certified by the firm´s auditor and

[78] There are cases where the hour accounts are doubled.

specifying the different types of costs. In practice, the process of controlling whether a certified auditor has in fact controlled the firms' R&D costs is inefficient. We suggest implementation of a digital signature for authorised auditors, similar to the signature related to the personal tax returns. With such a signature, one could make sure that claims lacking a signature where refused. Furthermore, the regulations should specify the obligations of the approving auditor, and which minimum of steps the auditor must take before approval.

- **Ensuring correct hours**: We suggest that firms and auditors are required to ensure that employees working on the R&D project confirm their project engagement.[79]
- **Excluding mature, but not profitable firms:** Limiting the scheme's eligibility to young firms (e.g. below 8 years as in France) can improve the effectiveness of the tax incentives, as this would exclude mature, but not successful firms, who potentially can be misusing the scheme.
- **Ensuring wanted collaboration only:** R&D purchased from other firms in a corporate group should only be allowed in the SkatteFUNN-accounts if the supplier has agreed to presenting accounts to the tax authorities, who can confirm that the delivery has taken place, and that the pricing is according to the arm´s length principle
- **Limiting the involvement of foreign firms:** The tax ceilings of SkatteFUNN provide an incentive to organize R&D activities in own firms and start new subsidiaries as soon as you reach the ceiling. To cope with this type of potential unwanted behaviour, an option could be to limit the opportunity to purchase R&D, especially from firms in other countries, or strengthen the documentation requirements. In addition, R&D purchased from foreign countries may only be entered into the SkatteFUNN-accounts if Norway as an agreement with the country on cooperation in tax matters.
- **Limiting firms or subsidiaries established to sell their R&D:** As part of the reporting, the firm should be obliged to confirm that the R&D results are for the firm's own purpose, and have not been licensed to any other firm, for example in a corporate group, without being sufficiently paid.
- **Control:** Both the RCN and the tax authorities should increase their control-activity.[80] Both the RCN and the tax authorities should establish risk based models for identifying applications that should be given enhanced assessment and projects/firms that should be inspected. We also recommend random tests to reveal misuse, mainly as this will make the scheme easier to evaluate, but also to have a deterrent effect. This would in turn improve the legitimacy of SkatteFUNN. These controls could also be at least partly self-financing.
- **Sanctions:** Sanctions could be reclaiming the incorrect tax credit retroactively, imposing punitive taxes in addition, and normal penal sanctions such as fines or prison punishment.[81] Another sanction, which no countries currently have, could be that a firm abusing the tax incentive is barred from claiming it for some years in the future or should be subject to special control requirements for the next applications or claims. The only instance indicating a move in this direction was identified in the UK which has recently (summer 2016) proposed to introduce measures that apply sanctions to the most persistent users of tax avoidance schemes, including R&D tax reliefs. Under the proposal, a 'serial

[79] This requirement does already follow the regulations. The problem is that it is probably not followed up properly by firms and auditors.
[80] The question of financing this through a fee to be paid by firms at fault could be considered.
[81] All these sanctions are included in the taxation law, and apply also in the SkatteFUNN context.

avoider' who repeatedly exploits R&D tax relief in a way not intended, could be denied access for a period of 3 years. In its 'Advance Assurance' scheme, HMRC rules deny the use of this scheme to firms that have used tax avoidance schemes or are 'serious defaulters'. Furthermore, we suggest that an auditor who incorrectly has approved a SkatteFUNN-claim should be barred from approving such claims for an appropriate number of years, and who have been barred should be available in a public register. This could be a way of increasing the auditor's sense of responsibility.

8.5 What to expect before final version of the evaluation

We have found examples of what can be interpreted as tax motivated misuse of the scheme, but to some extent one must accept this as a cost to subsidy and support schemes intended for use by many firms. This is particularly so when administrative expenditures and control routines are kept at a low level. A general issue is to divide costs between what is relevant for the R&D project and what is ordinary operating expenses. In addition, it is difficult to evaluate whether the outcome of the R&D project is for the firm, or if it is ordered.

During the spring we are expecting to receive data from the Tax administration related to misuse of SkatteFUNN. This will enable us to link the information on tax deduction for each firm with accounting information and the R&D reporting to Statistics Norway.

9 Distortive effects on competition and trade

We have assessed potential distortive effects of SkatteFUNN on competition and trade. These may be positive, as well as negative. First of all, SkatteFUNN is neutral by design. Being a rights-based scheme, there is no selection bias related to receiving SkatteFUNN. Neutrality is achieved along most other domestic dimensions, including geographic location, industry, ownership, result, and subject of research. We do find evidence of a slight favouring of SMEs, as intended, which arguably has a positive impact on competition as it reduces the entry barriers and counteracts the bias towards large firms by other available R&D schemes. We do not find any evidence that firms receiving SkatteFUNN have any negative impact on non-beneficiaries.

Internationally, we find that a relatively small share of the exporting recipients receives aid above the threshold of de minimis aid. It is also important to note that even if support exceeds this threshold, it need not be distortive. Furthermore, users of SkatteFUNN are found to import more from foreign firms, which is a positive externality for Norway's trading partners.

To the extent that there are distortive effects of SkatteFUNN they are probably applicable also to most of the other member states having similar arrangements, levelling out the distortions. Overall, we argue that the positive distortive effects probably outweigh the negative.

9.1 SkatteFUNN and potential distortive effects

Schemes implemented to enhance R&D are typically meant to remedy the suboptimal level of investment caused by the presence of externalities and informational asymmetries, as discussed in chapter 2. However, one should bear in mind that this kind of aid also may give rise to inefficiencies.

Schemes that distort competition are prohibited by EU law, unless they are targeted at specific objectives of EU interest and distortions of competition and trade are kept at an acceptable level.[82] It is important that measures enhancing R&D bring about a higher level of R&D activities than would otherwise occur, while ensuring that the positive effects outweigh potential negative effects in terms of distortions of competition in the internal market.

Uniform rules on R&D state aid at the EU level are necessary to ensure uniform conditions for the granting of aid. A situation without rules would not ensure equal treatment, legal certainty or predictability, and could lead member states to compete on measures, which could highly damage trade and competition within the internal market. However, even though the state aid rules apply within the EU, there is a large variation between countries in terms of how much R&D support is given. Thus, the treaty does not guarantee the same conditions of competition at this point.

SkatteFUNN was notified to ESA as an R&D scheme in accordance with EU's general block exemption in 2009 (EU 651/2014). The scheme has been preapproved by ESA. However, the preapproval also implies that the Norwegian authorities conduct an impact evaluation, which we present in this report, in line with the EU Guidelines on Regional State Aid. We see it as an important aspect of this evaluation to assess SkatteFUNN's potential impact on competition and trade.

In general, R&D tax incentives typically passes the exemption for state aid by ESA, if the scheme is not

[82] According to article 107 of the Treaty of Rome. The Treaty places the responsibility for the control of State aids in the hands of the European Commission as an independent supra-national authority.

focused on certain areas of specialization or regions. Direct grants and subsidies however, being more focused by definition, will more likely favour some firms and therefore potentially harm competition.

To analyse the possible distortions on competition and trade of SkatteFUNN we must consider several factors, pointed out by the European commission in their guide for balancing the positive and negative impact of state aid.[83] The overall objective of State aid evaluation is to assess the relative positive and negative effects of a scheme.

In this chapter we assess the effects SkatteFUNN may have on the domestic and the international competitive environment respectively:

- Domestically, any governmental measure can potentially be distortive, this is especially the case if there is a certain degree of selectivity, i.e. if it is directed to a specific industry or region that are enabled to increase their marked share, and thus distort competition. Marked shares can be gained by SkatteFUNN enabling firms to increase the quality of their products (if additionality is high) or reduce their prices (if additionality is low).
- Internationally, recipients of SkatteFUNN can also potentially increase their market share at the expense of foreign firms. An important indicator of potential distortion is the scope of the aid and the degree of activity on the international market of beneficiaries. According to EU regulation, if total aid received by a firm is less than € 200 000 over a three-year period, it is deemed as not large enough to have an impact on trade and competition. It is important to note that even if support exceeds this threshold, it is not necessarily distortive.

In this chapter, we will consider possible distortive effects of SkatteFUNN, focussing on domestic effects first and then on international competition and trade.

9.2 Domestic competition

The impact of SkatteFUNN on domestic competition will depend on firms' access to aid. The neutral nature of SkatteFUNN limits its distortive potential. Being a rights-based scheme, there is no selection bias related to receiving SkatteFUNN.

However, we find that SkatteFUNN is used more by firms and industries with a large share of R&D activity. For example, a larger share of firms in the ICT industry and technical services benefits from SkatteFUNN, compared to for example firms in health care. However, it is important to note that R&D intensity is endogenous, meaning that the R&D intensity of firms or industries can change. For example, due to SkatteFUNN, but more likely due to their competitive environment or income. The main question is whether SkatteFUNN succeeds in lifting R&D investments (closer) to the socially optimal level as described in chapter 2, without causing unduly market distortion.

SkatteFUNN's neutrality gives all firms the opportunity to receive tax credit for R&D expenses

R&D tax incentives typically give lower distortive effects on domestic competition compared to direct R&D subsidies, because they do not target specific

[83] See Common principles for an economic assessment of the compatibility of State aid under Article 87.3.

sectors or industries and do not interfere with market mechanisms.[84]

Although there is no bias related to receiving SkatteFUNN, the impact of the scheme can be biased. R&D tax incentives can have a bias toward incumbents or firms with a high degree of market power as they are more inclined to utilise the cost ceilings of the scheme to enhance their production. On the other hand, lowering the investment costs of R&D might lower entry costs, and thereby increase competition. Finding that the majority of SkatteFUNN users are SMEs, the latter seems more likely.

When assessing SkatteFUNN's impact on competition, it is also relevant to compare SkatteFUNN with other R&D enhancing instruments. When SkatteFUNN was implemented, an important argument was that it would reduce the barrier for SMEs to engage in R&D activities. It is not the case that SkatteFUNN exclude larger firms, it is rather the case that other R&D enhancing instruments exclude SMEs. This is often due to a complicated application process or requirements for the project that cannot be met by SMEs. We therefore argue that SkatteFUNN contributes to reducing an inconvenience experienced by SMEs due to the design of the portfolio of measures enhancing R&D. Increasing the market shares for SMEs is a positive distortive impact of SkatteFUNN, creating a healthier competitive environment.

Another important and accredited characteristic is that the tax incentive is refundable as cash for firms who are not tax liable (Elschner, Ernst, Licht, & Spengel, 2011). The idea is that the disbursements will particularly strengthen the liquidity of SMEs in the start-up phase, when R&D activities have not yet resulted in income. Including disbursements as an option arguably makes the scheme more neutral because it enables all firms to gain from SkatteFUNN, not only the profitable ones.

If SkatteFUNN is used as a means of survival or prevention of exit for unprofitable firms, then this is an unwanted consequence. It is not the objective of SkatteFUNN to affect the industrial structure, and funding unprofitable firms would be unintentional and unwanted. It could also potentially be a sign of misuse of the scheme if firms benefit from a generous public scheme to keep their business afloat.[85]

Finally, in a case of low or zero additionality, i.e. if firms receive support for R&D activity they would have done anyway, SkatteFUNN could be used to compete on pricing. In practice, we do not regard this an issue, as we find evidence of high additionality.

Ceilings may cause unwanted firm behaviour

Cost ceilings indirectly target firms based on their size, as smaller firms tend to have relatively lower costs related to R&D, compared to larger firms. Hence, smaller firms are more likely to have project expenses below the ceiling. In addition to the cost ceilings, SkatteFUNN does favour SME's by entitling them to a tax deduction of up to 20 percent on their R&D project costs, compared to 18 percent for large firms. As argued above, this slight favouring of SMEs does not have a negative distortive impact on competition, rather it enhances competition by providing market shares to SMEs.

A disadvantage of ceilings is that they provide an incentive to distribute expenses on R&D over time and over subcontractors to obtain the maximum tax

[84] However, several of the international R&D tax incentives target certain firm characteristics, making them less neutral than SkatteFUNN. For example, some schemes have a lower tax deduction for foreign-owned firms, as is the case in Canada.

[85] See chapter 8 from more about this potential for misuse.

credit. When it comes to SkatteFUNN, the incentive to make such adjustments is only relevant for larger firms. In 2015, only about 4.5 percent utilised the cost ceiling for internal costs of R&D projects, and less than 0.5 percent utilised the full cost ceiling of both intramural and purchased R&D costs from an approved institution. That only a small share of firms utilise the full cost ceiling indicate that this is probably not a significant issue.

The impact of SkatteFUNN on non-recipients

That the tax deduction is not received by all firms, may cause a negative distortive impact. Firms benefitting from SkatteFUNN can potentially increase their market share, at the expense of firms who does not receive support from SkatteFUNN. We argue that the neutrality of the scheme limits this distortion.

Furthermore, we have estimated the reaction of a given firm to changes in R&D expenditure made by other firms belonging to the same industry or geographic area. We do not find that the productivity of firms without own R&D activity is significantly affected by being part of an R&D intensive industry or located in an R&D intensive area. For more information on this see chapter 5. This supports our argument that the potential negative impact on firms who do not benefit from SkatteFUNN is limited.

9.3 International competition

The growing number of countries with R&D tax incentives reduces the chance of distortive effects on competition and trade internationally, see e.g. Cunningham, Shapira, Edler and Gok (2016). In the US, where 40 states have introduced R&D tax credits, they argue that the measure is no longer an incentive, but a prerequisite. In the EU 22 of 28 countries have implemented some sort of R&D tax incentive (OECD, 2016).

For SkatteFUNN to have a distortive impact on international trade, at least two conditions must be fulfilled. Firstly, support must be given to Norwegian firms selling goods and services on the international market. Secondly, the amount of aid granted must be of such a magnitude that it is likely to affect the firm's market adaptation at the expense of foreign firms without access to an equivalent aid. SkatteFUNN may also have an impact on international competition by enabling recipients to gain market shares. However, most of these are registered with a Norwegian organisational number, and could therefore themselves receive a tax deduction through SkatteFUNN.

In this chapter we will discuss the potential for distortion on international competition by SkatteFUNN, including an empirical analysis of the international activity by beneficiaries of SkatteFUNN.

Tax incentives can distort firms' location decisions and profit shifting

A large body of literature has documented that differences in corporate taxes are important for the location of a firm's capital and profits (Straathof, et al., 2014). Firms have an incentive to arrange their activities in such a way that, all else equal, profits accrue in the country in which they would pay the lowest tax. The existence of a R&D tax incentive in a country can generate a negative externality for private investment in R&D in neighbouring countries. Firms are not established where their social return is highest, but where they can receive the most aid. If such negative externalities exist, then non-cooperative governments are likely to compete for the highest tax incentives.

There are several strategies that can be used by firms to exploit generous R&D tax incentives in other countries. Such strategies commonly require that the income earned from exploiting intellectual property or other gains from R&D activities accrues

outside of the country in which the underlying R&D took place. One way to achieve this is through contract R&D. For example, a subsidiary in a country with relatively low taxes may finance (and bear the risk of) R&D activities that are contracted to a related subsidiary in a country with generous R&D enhancing measures. The contract will specify the payment to be made for the R&D activities. There is a tax advantage to this strategy if the costs of purchasing the R&D is inflated or if the true value of the R&D activities is less than the price paid for the contract R&D.

A similar result may be achieved using a cost sharing agreement that specifies how subsidiaries will share the costs, risks and returns associated with an R&D project. Such agreements may be designed to exploit and capture the returns from R&D accrued by a subsidiary in a low tax country (Griffith, Miller, & O'Connell, 2014).

Straathof et al. (2014) concludes in their meta study that it is especially large multinational firms that engage in profit-shifting activities to decrease the overall tax liabilities. Intangible assets, like patents, play an important role as they are relatively easy to move from one location to another. In addition, for large firms, innovation often is an international activity. Firms may perform R&D in one country, patent the product in another and commercialize it in a third one. Studies show that a strong negative relation persists between corporate income tax and the number of patents registered in a country (Straathof, et al., 2014). SMEs have less opportunity to conduct income shifting activities or tax planning (Bartelsman & Beetsma, 2003). All this may distort competition and result in overall lower welfare.

Grubert (2003) studied parent firms from the US and their manufacturing subsidiaries, and found that R&D related intangible assets were responsible for around half of the income that was shifted from high-tax to low tax countries. Transactions among the affiliations of a firm are hard to tax properly as it is difficult to assess the price of services within a firm. The reason for this is that intangible property transferred within a firm is very firm-specific. A comparable transfer may not exist in the market, and its price is therefore not observed.

De Mooij and Ederveen (2003) found in their meta study that a decrease by one percentage point in the host country's tax rate leads to an increase of foreign direct investment by around 3.3 percent. Desai et al. (2006) utilise firm level data of American firms to conclude that R&D expenditures are especially sensitive to changes in corporate taxes. For states in the US, Wilson (2009) finds that R&D tax incentives attract R&D from other states, while the overall amount of R&D is not affected. Indicating a distortion of firm localisation decision. However, the study does not include documentation of whether the scheme attracts foreign firms, i.e. from outside the US. There are reasons to believe that the locational effects of such schemes are less pronounced elsewhere. In Europe, and for some factors maybe for Norway in particular, the differences between countries in language, currency, culture, climate, and so on will differ far more than between states in the US. Furthermore, considering the relatively modest ceiling for SkatteFUNN and the fact that the scheme provides a tax credit for just 18 to 20 percent of the total R&D investment costs, the remaining 80 to 82 per cent must be paid by the firm itself, it seems unlikely that SkatteFUNN provides sufficient incentives for international firms to relocate to Norway in a significant scale.

In 2015, only 2.5 percent of firms in Norway were subsidiaries controlled directly or indirectly by foreign firms. About half of these firms are controlled by owners in the Nordic countries. The share has been weakly increasing over several years, but

there has been a decrease in their investments in 2014 and 2015. Which are years where the ceilings of SkatteFUNN increased significantly. It is important to note that, although the share of foreign controlled firms in Norway is fairly small, the foreign owned firms are large. Around 40 percent of firms in Norway with more than 250 employees are indirectly or directly owned by a foreign firm.

To say something about SkatteFUNN's impact on foreign firms' decision to set up a subsidiary in Norway, it is relevant to look at the establishment of firms owned by foreign firms from countries without an R&D tax incentive. In the evaluation of the Austrian scheme, Ecker et al. (2017) found a positive impact of their R&D incentive on the attraction of foreign firms to Austria, and in particular from Germany, who does not have an R&D incentive. In Norway, the share of foreign controlled firms that is controlled by a German firm is only 4.6 percent in 2015. The share has also been decreasing as the generosity of SkatteFUNN increased. Although, we cannot state the explicit causal relationship between SkatteFUNN and the attractiveness of Norway to locate R&D intensive firms, the statistics do not indicate substantial relationship.

Griffith, Miller, & O'Connell (2014) model the impact of taxes on where firms choose to locate the legal ownership of patents. They find that corporate tax rates are an important determinant of location choice. However, the number of patents applied for in Norway does not seem to be sensitive to corporate tax changes in other countries. This is an indication that lower taxes in Norway, relative to other European countries, may not attract foregin investments in R&D (Griffith, Miller, & O'Connell, 2014).

This must, nonetheless, be interpreted with caution as patents registered in a country does not necessarily reflect innovativeness. The country from which a patent is applied for is not necessarily where the invention originated (Straathof, et al., 2014). Especially larger firms might apply for patents from countries other than those where they perform their R&D, as they tend to have subsidiaries dedicated to IP-issues, possibly due to patent advantages in countries with patent box schemes.[86]

The introduction of patent boxes by several European countries in a relatively short space of time has given rise to concerns that countries are engaging in tax competition for patent income. The European Commission (2016) is amongst those who perfers tax allowances or credits based on R&D costs, rather than patent boxes. This is because few studies find a stimulating impact on R&D from patent boxes, but several studies find that these schemes are used as a profit-shifting instrument (Alstadsæter et al., 2015). Straathof et al. (2014) also argues that patent boxes, rather than tax incentives, are utilised for profit-shifting operations and that it leads to unwanted tax competition between the countries.

Compared to the US, European firms are less likely to move or start subsidiaries due to changes in tax policy. Dischinger et al. (2014) found that the profits of European multinationals tend to concentrate in the country of their headquarters. They showed that the volume of profit-shifting from a higher-tax subsidiary to a lower-tax headquarter was around seventy percent larger than the volume running from a high-tax headquarter to a low-tax subsidiary. However, the intangible asset investments and patent applications do flow to those subsidiaries that, relative to other subsidiaries, have lower tax rates

[86] Patent boxes refers to preferential tax regimes for income from patents.

(Griffith, Miller, & O'Connell, 2014; Dischinger & Riedel, 2011; Karkinsky & Riedel, 2012).

More generally, there may be characteristics of a location over and above its corporate tax rate that firms value. For example, the strength of intellectual property rights protection and market size might play a role, and, all else equal, firms may be more likely to co-locate ownership of intellectual property with associated real innovative activity due to externalities from co-location (Griffith, Miller, & O'Connell, 2014).

Multinationals have wide access to finance and cross-border tax planning possibilities that put them at an advantageous position with respect to domestic firms. Additional support to multinationals could result in large dead-weight losses and a distorted competitive environment. A solution could be to reduce the tax incentives for large multinational firms or limit the project costs of R&D activities performed outside of the country. This is something that can be considered as part of SkatteFUNN.

None of the European countries studied in Griffith, Miller and O'Connell (2014) require that the R&D underlying the intellectual property took place in the country providing the tax incentive, as this is not permissible under European law.[87] However, both Canada, Australia and the US are amongst the countries that maintain provisions that the R&D activities must be performed in the country eligible for tax incentives (partly or fully). Some other countries maintain provisions that intellectual property rights resulting from R&D are owned by the country providing the tax incentive.

SkatteFUNN is arguably a scheme that enhances the competitive environment for SMEs, who are not able to participate in profit-shifting activities, rather than being a scheme distorting international firms' location decisions (Bartelsman & Beetsma, 2003).

SkatteFUNN users import more

Bøler, Moxnes and Ulltveit-Moe (2015) studied the impact of an R&D cost shock on R&D investments, imported inputs and their joint impact on firm performance. The R&D cost shock is SkatteFUNN. By including imported inputs into a model of R&D and endogenous productivity, they show that R&D and international sourcing are complementary activities.

They found that receiving support through SkatteFUNN did have an impact on firms R&D investments, but more importantly in this aspect; users of SkatteFUNN purchased more intermediates from foreign firms, compared to other firms. This indicate that SkatteFUNN actually has a positive external impact on foreign firms as the demand for their products increases.

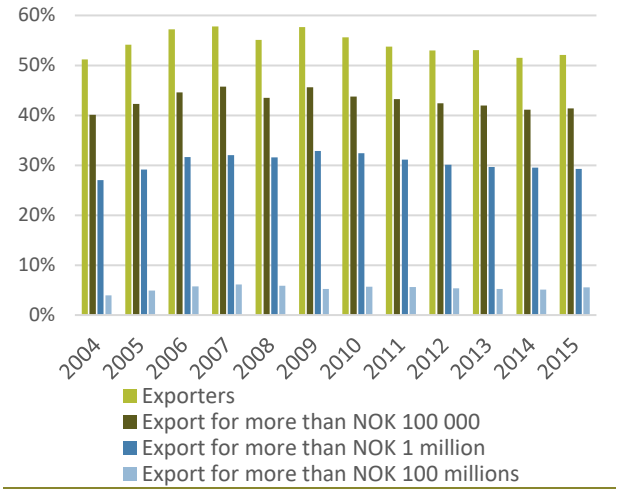
SkatteFUNN and exporting firms

For SkatteFUNN to have a negative distortive impact on international trade, the benefitting firm must be an exporter or strengthen its competitiveness in the Norwegian market compared with foreign suppliers.

Figure 9.1 illustrates that around half of the benefitting firms are exporting. However, the exporting value for most of these are relatively low. The median export value of the exporting SkatteFUNN recipients was slightly above NOK 2 million in 2015. Figure 9.1 also illustrates that the share of exporting SkatteFUNN recipients, by value of export, is relatively stable. Around 30 percent of the SkatteFUNN recipients export for more than NOK 1 million.

[87] The countries studied includes Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Spain, Norway, Sweden, Switzerland and the UK.

Figure 9.1 The share of SkatteFUNN recipients who export, by value of export



Source: XX

In addition to being an exporter, the amount of aid granted must be such that it likely will affect the firm's market access at the expense of firms in other countries, that do not have access to an equivalent scheme.

We do not have access to the international firm level data necessary to estimate the impact of SkatteFUNN on international firms. We can therefore not conclude on the aggregated effects of SkatteFUNN on international competition and trade. We do, however, have access to information about the Norwegian firms and aid from SkatteFUNN.

The median size of tax deduction for exporting SkatteFUNN recipients was slightly less than NOK 700 000 and the maximum was NOK 6,6 million in 2015.[88] It was, however, only one exporting firm who utilized the increased ceiling for purchased R&D. The increased ceiling provides a useful contribution to larger firms, but our findings indicate that a relatively small number of firms can utilise such a large cost ceiling.

For the firms who exported but were not tax liable and therefore received a paid amount through SkatteFUNN, the median was slightly above NOK 350 000.

According to EU regulation, aid received by a firm amounting to below € 200 000 for a three-year period is deemed as not large enough to have a distortive impact on trade and competition (de minimis aid).[89] Support above this threshold does, however, not necessarily cause distortion, but it might.

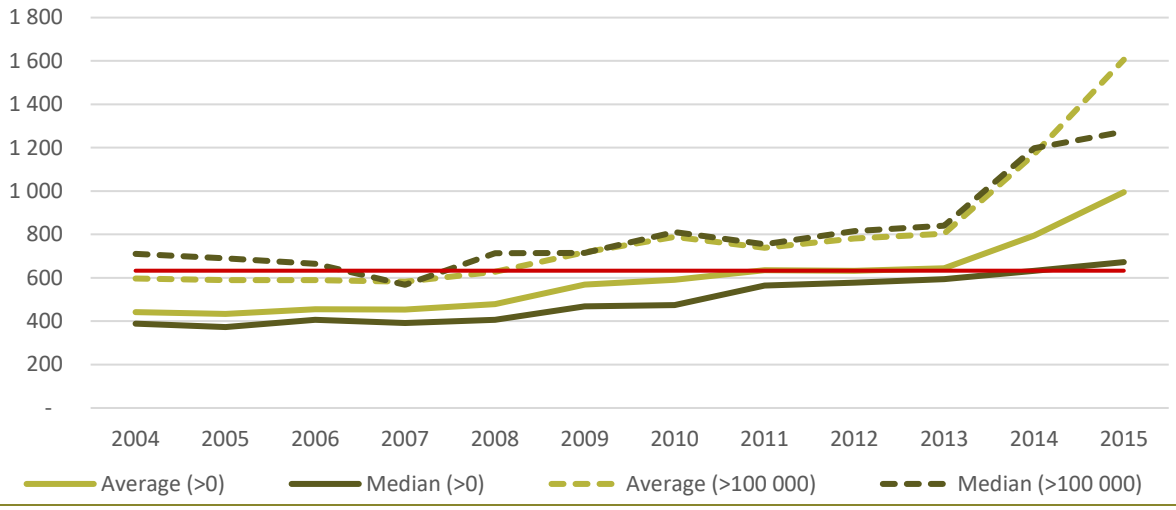
The € 200 000 for a three-year is equivalent to slightly less than NOK 650 000 per year. When it comes to SkatteFUNN beneficiaries, most have been below this threshold for almost every year since SkatteFUNN was implemented, cf. Figure 9.2. However, with the large increases in generosity over the past few years, due to the rising ceiling, several firms receive tax deductions above this threshold.

The share of firms exceeding the threshold has increased significantly with the expansions of SkatteFUNN. In 2015, there was a significant share of exporting firms above the threshold. It follows that we cannot rule out distortive effects based on this formal definition.

[88] This is significantly larger than the median aid given to SkatteFUNN users in total.

[89] See the Official EN Journal of the European Union for more information.

Figure 9.2 Development of average and median tax deduction through SkatteFUNN by value of export in NOK 1000



Source: Statistics Norway and Samfunnsøkonomisk analyse

Figure 9.2 further illustrates that firms with exporting values above NOK 100 million is above the limit for *de minimis aid* (the red line) for most of the years. However, the share of exporting SkatteFUNN firms who export for more than NOK 100 million is only about 1 percent for the whole period. The activities of these large exporting SkatteFUNN beneficiaries are relatively evenly spread across industries. Indicating that they do not distort any single industries. The industries with the highest share of SkatteFUNN firms exporting for more than NOK 100 million per year included manufacture of other inorganic basic chemicals, instruments for measuring, testing and navigation, other parts and accessories for motor vehicles and aquaculture.

Whether activities performed by exporting firms receiving state aid above the threshold has a distortive impact on trade and competition is uncertain. Nevertheless, we cannot disregard that SkatteFUNN does have a negative impact on trade and competition. Given its modest scope, however, we view it as unlikely that such an impact would be large.

9.4 Does SkatteFUNN distort competition?

The question boils down to whether the costs of negative distortions are greater than the benefits from SkatteFUNN, including the benefits on competition. We will return to the benefits of SkatteFUNN in chapter 9. In this subchapter we will conclude on the net impact of SkatteFUNN on competition and trade.

There are several reasons why SkatteFUNN is unlikely to contribute to net negative distortive effects on trade and competition. We distinguish between domestic and international distortive effects.

Domestically, any governmental measure can potentially be distortive, this is especially the case if there is a certain degree of selectivity, i.e. if it is directed to a specific industry or region that are enabled to increase their marked share, and thus distort competition. Marked shares can be gained by SkatteFUNN enabling firms to increase the quality of their products (if additionality is high) or reduce their prices (if additionality is low).

SkatteFUNN is neutral by design. Being a rights-based scheme, there is no selection bias related to receiving SkatteFUNN. SkatteFUNN does, however, favour SMEs (both as a consequence of the more favourable tax rate for SMEs and the cost ceilings). This is as intended, and arguably has a positive impact on the competitive environment as it reduces the entry barriers and counteracts the bias towards large firms by other available R&D schemes.

We find a high and positive additionality of SkatteFUNN, especially for SMEs (cf. chapter 4), implying that market shares can be gained by beneficiaries due to increased product quality. Increasing the market shares for SMEs is a positive distortive impact of SkatteFUNN, creating a healthier competitive environment.

However, with the scheme's generosity expanding significantly over the past few years, the potential of distortive effects has risen. Given that a small share of firms utilises the new, higher cost caps, and that the main objective of the scheme is to support the SME-segment, we do not recommend further increases of the cap.

Internationally, we find that a relatively small share of the exporting recipients receives aid above the threshold of *de minimis aid*. It is also important to note that even if support exceeds this threshold, it need not be distortive. Furthermore, users of SkatteFUNN are found to import more from foreign firms, which is a positive externality for Norway's trading partners.

Overall, we argue that the distortive effects domestically appear to be positive and that the potential for negative distortions of international competition and trade is modest. This indicates that overall distortive effects of SkatteFUNN are limited and should not be of great concern given that the evaluation finds significant positive effects of the scheme. We argue that the positive distortive effects probably outweigh the negative.

10 Concluding remarks and recommendations

The main objective of this evaluation has been to assess to what extent SkatteFUNN increase R&D investments in the Norwegian business sector, especially among small and medium sized enterprises.

The evaluation has been carried out according to the Guidelines on State Aid (European Commission 2014). In line with these guidelines the evaluation has tested and analysed several data sets to assess whether SkatteFUNN:

- Is aimed at a well-defined objective of common interest
- Is designed to deliver the objective of common interest
- Limit the distortions of competition and trade

In this chapter we summarise our findings and provide our recommendations for further development. of SkatteFUNN

10.1 The objective is well-defined

Our review of the rationale of the SkatteFUNN scheme confirms that both the Hervik Committee laying the foundation for SkatteFUNN and the governmental white paper which established the scheme saw enhanced R&D in the business sector as necessary to secure productivity and sufficient future economic growth.

SkatteFUNN was proposed as one of several measures to increase R&D in the business sector. A tax deducting scheme as SkatteFUNN was particularly motivated by the need to stimulate smaller R&D projects, typically for SMEs. Large R&D projects could be easier and more targeted through existing direct research stimulating schemes.

We consider the objective of SkatteFUNN as well-defined, namely to contribute to increase R&D in the Norwegian business sector. In particular, we interpret the objective as enhancing R&D in SMEs.

Economic theory gives strong support to the schemes prerequisite that it is possible to increase the total value added in society through public stimulation of R&D in the business sector. R&D in firms increase productivity growth and production opportunities. R&D projects also have external effects for other firms and the overall society. The external effects are not fully internalised by the individual decision makers.

Free riding could also lead to underinvestment, as a firm may be likely to benefit from other firms' investments in R&D, a disincentive to be the "first mover". Furthermore, it is often difficult for enterprises to obtain funding for innovation projects in the private market. The information possessed by the enterprise and the investor is typically highly asymmetric, causing higher risk

Public support to reduce firms R&D costs could enhance the amount and scale of R&D projects and thus bring the R&D investment closer to the social optimum.

10.2 SkatteFUNN is designed to deliver the objective of common interest

R&D in the business sector enhance productivity

In chapter 5 we have tested whether R&D investments in the business sector have positive and significant effects on labour productivity, and thus increase total income in society. If so it may be possible to increase R&D further to take into account that each firm does not internalise all the social benefits of own R&D investments.

Overall, the results show that R&D investments in the business sector in general, over time, enhance labour productivity. Moreover, our results tell us that

both SkatteFUNN projects and direct support from the RCN have the same effect on labour productivity as R&D projects fully financed by the firms themselves. This is unexpected, although in line with the results of the previous evaluation of SkatteFUNN, since projects supported by RCN and SkatteFUNN are thought to be of higher risk and/or lower expected payoff than R&D carried out without public support. However, our results are dependent on how much we adjust our sample to avoid outliers.

The external effects of R&D are difficult to measure quantitively. We apply a "distance to R&D" approach to identify spillovers, though the results of this econometric analysis are inconclusive. In the web survey conducted in our study, firms were asked what impact their SkatteFUNN projects might have contributed to outside the firm. The most frequently reported impact was that the projects have benefited the firms' costumers, mainly in terms of better products or services. Moreover, a majority of respondents answered that strengthened competitiveness for other firms and dissemination of competence through staff mobility and cooperation were results of the SkatteFUNN project(s).

The result substantiate that it is possible to achieve social gains from increasing R&D investment in the business sector. However, this is only the case if SkatteFUNN actually contributes to realize projects that otherwise would not have be realized.

High and positive input additionality

SkatteFUNN's main objective is to enhance R&D in SMEs. Two potential results would confirm that SkatteFUNN is designed to achieve its objective:

- If data confirm that the scheme contributes to realize projects that otherwise would not have be realized, i.e. input additionality
- If data confirm that the scheme meets its main target group; SMEs

In chapter 4 we have conducted a comprehensive test of the scheme's input additionality. We apply two different approaches to estimate the input additionality of SkatteFUNN. The first approach evaluates the effect of an increase in the project cost cap in 2009. This approach confirms that only firms with R&D expenditures under the project cost cap are stimulated to increase their R&D efforts.

The second approach is more general and study how different changes in the scheme have affected firms' R&D behaviour. This approach shows that SkatteFUNN have high input additionality, but effects vary a lot depending on the type of change and the type of user-generation.

We define a generation as the new users linked to a certain change in the scheme, in turn leading to what we call a new regime. Overall, weighted over all generations, input additionality is reduced over time. This is because new generations are associated with lower additionality, while the earlier generations tend to keep their higher additionality over time/regimes. Our interpretation is that the most competent firms are also the most efficient to sign up for SkatteFUNN. It follows that the pool of highly efficient firms was (almost) emptied at the introduction of the scheme, and therefore accounts for an even smaller proportion of the following generations.

When we look into the size of the SkatteFUNN users, we see that the scheme is especially relevant for SMEs – the schemes target group.

Around half of the recipients of R&D tax credits are firms with less than 10 employees. However, the share of firms with less than 10 employees has decreased over time among those who continuously use SkatteFUNN. This is reasonable, given that the main share of recipients are firms that continues to use the scheme; both firm age and size increases.

This is a significantly larger share relative to comparable schemes (e.g. the RCN's BIA[90]).

Among new applicants the share of firms with less than 10 employees have been relatively stable over time. Furthermore, above 80 percent of new applicants, as well as the "regulars", are firms with less than 50 employees.

There is reason to assume that the relevance for SMEs is largely a consequence of SkatteFUNN's basic characteristics as a rights-based scheme. SkatteFUNN differs from direct subsidy schemes where aid require a more comprehensive process of approval. SkatteFUNN is not only a low threshold scheme but also applies to all firm sizes. Firms can themselves decide which projects to invest in, as long as projects creates new knowledge or new experiences in association with development or improvement of goods, services or processes.

Put together it is our clear assessment that SkatteFUNN meets its objective and are well designed to do so

Misuse is likely limited

There are examples of what can be interpreted as tax motivated misuse of SkatteFUNN. We have no reason to believe that it is extensive, but it is impossible to quantify due to the present lack of data [Note: we are expecting data from the Tax administration during the spring, hopefully in time for the final report].

To some extent, however, one must accept misuse as a cost to support schemes intending to attract many firms. This is particularly so when, as is the case with SkatteFUNN, control routines and administrative expenditures are kept at a low level.

10.3 Minor distortive effects on competition and trade

When we assess the schemes distortive effects on competition and trade, it is important to note that the distortive effects on competition and trade can be both positive and negative. SkatteFUNN could distort competition by increasing the market shares of recipients at the expense of other firms (both domestic and international). However, we argue that this increase probably reduces existing inefficiencies and has a positive distortive impact on competition.

There are several reasons why SkatteFUNN is unlikely to contribute to net negative distortive effects on trade and competition. We distinguish between domestic and international distortive effects.

Domestically, any governmental measure can potentially be distortive, this is especially the case if there is a certain degree of selectivity, i.e. if it is directed to a specific industry or region that are enabled to increase their marked share, and thus distort competition. Marked shares can be gained by SkatteFUNN enabling firms to increase the quality of their products (if additionality is high) or reduce their prices (if additionality is low).

SkatteFUNN is neutral by design. Being a rights-based scheme, there is no selection bias related to receiving SkatteFUNN. SkatteFUNN does, however, favour SMEs (both as a consequence of the more favourable tax rate for SMEs and the cost cap). This is as intended, and arguably has a positive impact on the competitive environment as it reduces the entry barriers and counteracts the bias towards large firms by other available R&D schemes.

[90] See Røtnes, Flatval and Bjøru (2017).

We find a high and positive additionality of SkatteFUNN, especially for SMEs (cf. chapter 4), implying that market shares can be gained by beneficiaries due to increased product quality. Increasing the market shares for SMEs is a positive distortive impact of SkatteFUNN, creating a healthier competitive environment.

However, with the scheme's generosity expanding significantly over the past few years, the potential of distortive effects has risen. Given that a small share of firms utilises the new, higher cost caps, and that the main objective of the scheme is to support the SME-segment, we do not recommend further increases of the cap.

Internationally, we find that a relatively small share of the exporting recipients receives aid above the threshold of *de minimis aid*. It is also important to note that even if support exceeds this threshold, it need not be distortive. Furthermore, users of SkatteFUNN are found to import more from foreign firms, which is a positive externality for Norway's trading partners.

Overall, we argue that the positive distortive effects probably outweigh the negative.

10.4 The benefits of SkatteFUNN outweigh the cost

Even if a public support scheme has positive social effects, it will also have social costs. The benefit, i.e. the value-added effects from increased R&D investments, must be higher than the social cost of the public contribution (cost of taxation), the net effects on trade and competition and misuse of the scheme.

A significant part of the private economic gains that is attributable to SkatteFUNN accrues the participants in terms of return on their additional R&D investments, development of their production processes and further improvement of their productivity, but by far everything. For the overall economy, the main economic effect is the increase in productivity for all firms through the positive knowledge spill-overs that are the main attribute of R&D.

It is challenging to determine to what degree higher growth among SkatteFUNN participants contribute to higher value added in the overall economy. However, based on the empirical analysis in Chapters 4 and 5, it is possible to estimate whether the additional value added resulting from additional R&D expenditures under participation in SkatteFUNN exceeds the social costs in the form of loss in taxes. If it does, it is a clear indication that the social benefits of SkatteFUNN exceeds the social costs.

Our estimates from Chapter 4 indicate that SkatteFUNN firms invest 2 kroner more in R&D per 1 krone of tax credit they receive. That implies that NOK 1 billion of tax credit results in NOK 2 billion of extra R&D investment in the so called "knowledge capital" (1 billion private investment and 1 billion through SkatteFUNN). Our estimates from Chapter 5 indicate that the rate of return on additional R&D through SkatteFUNN is not significantly different from the rate of return on R&D in general and is equal to 8.2 percent. That gives us additional value added equal to 2*0.082 = 0.164 or NOK 164 million in the first year after investment.

At the same time, that SkatteFUNN is a tax-financed program, which means that the social costs associated with the public funding exceed the government's direct costs. To adjust for the efficiency loss in the economy of tax financing activities, it is common to assume that the social cost is 20 pct. higher than the public spending. Overall, NOK 1 billion

through SkatteFUNN triggers NOK 2 billion of private investments. Including the efficiency loss, we end up with total social costs of NOK 2.2 billion.

If we assume that there is no depreciation of R&D capital (which might seem unrealistic) the private gain would equal social costs after 14 years. However, it is normal in the literature to depreciate R&D capital with 0.15 (the rate we have used to calculate R&D capital in chapter 6). With this depreciation rate the yearly gain in the form of additional value-added fall very fast. Reaching NOK 1 billion after 16 years the gain is not increasing to more than 1.1 billion after 40 years. This amount covers only private investments, while public investment then is a pure subsidy of expected positive spill-overs from R&D. Without positive spill-overs R&D investments would not be socially lucrative.

One question that remains is what depreciation rate of R&D capital would result in socially profitable R&D investments even without positive spill-overs. The answer is 0.07, and is still far from zero. Thus, the conclusion whether SkatteFUNN is socially profitable or not is connected to the question whether R&D investments in general are socially profitable or not. The answer is yes if we believe that R&D have strong positive spill-overs (and the vast literature do[91]) or if the knowledge created has a long-lasting importance and is not depreciated too fast. The answer is no in the opposite case, when there are no positive spill-overs, or the created knowledge has a short-term importance.

10.5 Recommendations

We conclude that the benefits from SkatteFUNN of positive additionality and positive effects of competition and trade most likely exceed the costs of negative distortive effects and misuse. This leads us to a clear recommendation of continuing the SkatteFUNN scheme.

We also find that expanding the scheme by increasing the cost cap is no longer relevant for SMEs, as they in general are operating far below. The cost cap is now raised to such a high level that further increases will only affect large firms. This points to not expanding the scheme further, at least not until SMEs R&D investments have grown close to the present cap.

If the authorities wish to stimulate R&D on a general basis, they may as well consider alternative measures, i.e. through RCN or IN.

To further stimulate R&D in SMEs through SkatteFUNN, there are two relevant options, 1) increasing the tax credit rate for SMEs above today's 20 percent or 2) increasing the cap on hourly wage. Increasing the cap on the hourly wage rate could facilitate a more extensive use of senior researchers and trigger new research otherwise not taking place. In general, we argue for a predictable adjustment procedure to adjust for inflation.

We also recommend random tests to reveal misuse. This could also be at least partly self-financing, and would definitely make the scheme easier to evaluate. Another measure to increase the evaluability is to leave a few years between changes in the scheme. This would in turn improve the legitimacy of SkatteFUNN.

[91] See e.g. W. J. Baumol (2002) who shows that the possible spill-overs may vastly exceed the private gains.

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Appendix A – Survey of beneficiaries

A.1 Methodology and representativeness

Web survey

In April 2017, there were 38,853 projects in the SkatteFUNN project database. In order to select a sample representative of the entire population of SkatteFUNN projects, we went through a series of steps to eliminate projects (and thereby potential contacts) that were not deemed relevant to include in the user survey. A detailed description of this process is provided in Appendix X, in short it included elimination of:

- Inactive firms
- Projects without e-mail address to project leader
- Projects that are not completed
- Projects that are not approved
- Projects with missing firm NACE code
- Projects with missing number of firm employees
- All projects bar the most recently completed for each firm
- Firms missing year of establishment (or nonsense years)
- Projects starting before 2010
- Projects ending after 2016

These elimination steps resulted in a population of 4,247 firms (and an equal number of SkatteFUNN projects). From this population of firms, a sample of 1,500 firms were randomly selected to be invited to respond to the survey. The survey was conducted in Norwegian and survey invitations were sent out on 25 April 2017. Non-respondents were reminded on four occasions whereupon the survey closed on 7 June 2017. Some of the 1,500 e-mail addresses turned out to be inactive or incorrect, and while we made efforts to locate present addresses, in the end 241 invitations did not reach their intended contact. The survey resulted in a grand total of 600 responses, which corresponds to a response rate of 40 percent. The distribution of the responses, non-responses and response rate across business sectors and number of employees is provided in Appendix X.

As expected, there is a time effect in the propensity to respond. There is an almost linear correlation between the number of years since the project ended and the response rate until 2015, with an inexplicable drop in 2016. For projects that ended in 2010 the response rate was 20 percent, compared to 50 percent for projects that ended in 2015.

The firms constitute fairly accurate reflection of the original population. There are only small differences in terms of number of employees and a slight bias towards newer projects, i.e. ending in 2014–2016 (a consequence of the lower response rate for older projects). If we compare the responding firms and the original population in terms of repeat use of SkatteFUNN, we find that the responding firms on average have had more SkatteFUNN projects than the original population. This pattern is further confirmed by close to every other firm in the original population having only one SkatteFUNN project compared to a quarter of the responding firms. To summarise, the group of responding firms is a reasonably accurate (but not perfect) sample of the original population, with a slight bias towards firms with more recent projects and more intensive use of SkatteFUNN.

Interviews

We have also conducted 50 interviews to complement the survey. The bulk of the interviews were made with firms that have had SkatteFUNN project(s). The selection was made from the population of 4,247 firms described above, but excluding the survey population. The selection of interviewees was strategic, and we sought to obtain a mix of small and large firms that represented different sec-

tors and numbers of completed SkatteFUNN projects. This strategic approach was nevertheless hampered by a low propensity to agree to be interviewed, which introduced a significant level of "self-selection" among interviewees.

The interviews employed a semi-structured interview guide that allowed the interviewer to adapt questions to the interviewee's level of experience of SkatteFUNN, but still systematically pose a set of predetermined questions. The telephone interviews were conducted in Norwegian[92] in the period of May–August 2017.

In addition, we conducted a handful of complementary interviews with national stakeholders, including the Research Council of Norway (RCN), Innovation Norway (IN), the Industrial Development Corporation of Norway (Siva), the Confederation of Norwegian Enterprises (NHO), the Federation of Norwegian Industries and the Association of Norwegian Research Institutes (Forskningsinstituttenes fellesarena, FFA), to complete the interpretation and analysis of survey results and the interviews with SkatteFUNN users. We also (unsuccessfully) sought to interview The Norwegian Association of Higher Education Institutions.

NOTE: This appendix will be expanded in the final version.

[92] Interviewees spoke Norwegian whereas interviewers spoke Norwegian or Swedish (depending on who conducted the interview); the languages are close enough to be mutually intelligible.

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