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Evaluation of Norwegian Innovation Clusters

Report 76-2017



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Preface

Innovation Norway has commissioned Samfunnsøkonomisk analyse to evaluate the Norwegian Innovation Clusters program. The program is organized by Innovation Norway, in joint effort with Siva (The Industrial Development Corporation of Norway) and The Research Council of Norway. The Norwegian Innovation Clusters (NIC) program was launched in 2014 and aims at increasing growth by promoting and improving collaboration activities in the clusters.

Seven cluster projects were completed in 2016. These are evaluated as part of the commissioned program evaluation. The seven projects consist of four Norwegian Centres of Expertise (NCE) projects and three Arena projects.

Technopolis Group has contributed to the evaluation with an international comparison through three case studies of cluster programs in Germany, Denmark and France.

We would like to thank everyone who has willingly taken the time to answer all our questions. We would also like to thank members of the reference group for interesting discussions and useful feedback.

The evaluation has been conducted during the period from March to October 2017. Samfunnsøkonomisk analyse is responsible for all content in this report.

Oslo, 15 November 2017

Rolf Røtnes
Project manager
Samfunnsøkonomisk analyse AS

Summary

Norway has had a strategy to strengthen industry clusters through a national cluster program since the beginning of the 2000s. The Arena program was launched in 2002 and has since supported nearly 70 cluster projects. Norwegian Centres of Expertise (NCE) was launched in 2006 to further strengthen interactions in the Norwegian innovation system. NCE has supported 14 projects. In 2014, Arena and NCE were merged into one program; the Norwegian Innovation Clusters program (NIC). At the same time, Global Centres of Expertise (GCE) was initiated as a third level. GCE supports three cluster projects.

Arena targets clusters of newly established and/or immature collaboration initiatives. Arena clusters can be relatively small and primarily have a regional position, or be larger with a national position. Arena offers support to cluster projects with a duration of three years (phase 1). In addition, there is an opportunity to apply for a two-year extension of the project (phase 2). The grant per project is normally be within NOK 1.5-3 mill. pr. year.

NCE targets clusters with a well-established national position and further national and international growth potential. NCE offers support up to 10 years. The grant per project is normally be within NOK 4-6 mill. pr. year.

GCE targets clusters a well-established position within global value chains. GCE does not offer financial support for cluster development. The current cluster program limits GCE projects to maximum 10 years. The grant per project is normally be within NOK 8-10 mill. pr. year.

Norwegian Innovation Clusters has grown to become an important industry policy instrument

over the years. The cluster program had a total budget of NOK 166 million in 2016. The introduction of GCE increased the size of the program by about 25 percent.

Innovation Norway has commissioned Samfunnsøkonomisk analyse to conduct this evaluation of the Norwegian Innovation Clusters program, as well as an evaluation of seven completed cluster projects.

The main objective of this evaluation is to assess to what extent the program meets the needs of the target group, whether the operation and organisation of the program is appropriate and whether the effects are in accordance with the objectives.

The evaluation has assessed the following:

- To what extent the market or system failure constituting the rationale for the program is still present and if and what alternative measures that exist to compensate for these failures (relevance).
- Whether the cluster projects have achieved their stated objectives and whether they collectively contribute to achieving their program level's objective and the cluster program's common objectives (effectiveness).
- Organisation and operation of the cluster program, including an assessment of whether changes in organisation and operation has contributed to the program's relevance, effectiveness and efficiency.

There is a total of 47 cluster projects included in the current evaluation. Of these are 29 Arena projects, 15 NCE projects and three GCE projects. The first projects started around 2005, whereas

the latest started in 2016. If we do not distinguish between type of membership or degree of involvement, these clusters have almost 2 600 members.

For analytical purposes we have limited the sample of cluster members to limited liability companies (LLC). Further, we have limited the selection of members in each cluster to LLCs located in the economic region we consider to be the cluster's geographic localisation. As we want to focus on firm performance, we have chosen to exclude research institutes organised as limited liabilities.

The cluster projects are located all over Norway, but with variation in the number of projects per region. Arena targets cluster projects with a regional position and a significantly larger proportion of clusters at this level are in more rural regions, compared to NCE and GCE clusters, which are all located in central regions. However, there is a tendency for a larger proportion of new Arena clusters to be in central regions.

Looking at which industries that make up the largest proportion of members in the different clusters, it is apparent that professional, scientific and technical activities and ICT is the largest industry in several clusters, regardless of the cluster projects' objectives. Manufacturing represent, in relative terms, a significant share of employment across the three cluster levels, compared to the rest of the economy. Employment shares within selected manufacturing industries shows a clear orientation towards the petroleum industry among the cluster projects. It also appears that Arena and NCE clusters have a relative advantage within ICT and professional, scientific and technical activities. The relative advantage within ICT has become clearer in recent years.

Looking at the evaluation questions mentioned above, we conclude as follows:

The rationale for the program is still present

Our review of different theories of how clusters occur and how cluster dynamics can be stimulated shows that the Norwegian Innovation Cluster has developed an instrument that is adapted to strengthen dynamic effects in Norwegian clusters.

It is important to distinguish between cluster effects, i.e. effects resulting from collaboration in clusters, and effects of the cluster program. The cluster programs' role is to stimulate cluster development, or more specifically to *trigger collaboration-based development* which otherwise would not have happened, *and to reinforce and accelerate existing collaboration*. This is both about stimulating collaborative potential (relational basis) and specific collaboration processes.

It is our assessment that Norwegian Innovation Clusters is based on a solid academic basis and that there is reason to assume that the program activities should result in more collaborative activities, enhanced innovation, and subsequently increased value added, that would otherwise not have happened.

However, we do not find a theoretical justification for a cluster program with three levels, potentially supporting cluster projects for 20 years.

Cluster status enhances visibility and pride

When applying for admission into the program firms develop better knowledge of each other and search for new opportunities for collaboration. As a result, firms identify more with each other than before, desire to develop new meeting places,

collaboration projects increase and the pride of belonging to an acknowledged industry environment is clear both among the firms themselves and in the local community they are part of.

Interviews reveal that this positive attention contributes to an internal sense of pride, which in turn creates interest in contributing to the further development of the cluster project.

The cluster program's impact on the cluster's visibility, pride and identity is, in our opinion, primarily an argument that supports the continued uptake of new clusters in the program. However, the argument is conditional on the existence of positive effects on firm performance, as we find. If not, recognition and visibility could have been achieved in other and simpler ways (e.g. award ceremonies).

Significant growth in collaboration

In this evaluation we have analysed whether participation in a cluster project has had an impact on the firms' R&D collaboration networks. As our available data comprise detailed information about firms and research institutions that are engaged in different R&D projects we have been able to construct an R&D collaboration network for each cluster firm counting direct links between them and other R&D project collaborators. We have also constructed cluster networks, i.e. links between all firms and research institutions participating in the given cluster.

The results are striking. When we compare collaboration links before and after enrolment in a cluster, collaboration between cluster firms in the same cluster has been doubled in the Arena projects. Similar collaboration has more than doubled in the NCE projects. It is also a significant

increase in collaboration between cluster firms and R&D institutions in the same cluster.

Based on the above, it is our clear conclusion that Norwegian Innovation Clusters contributes to more innovation-oriented collaboration between members of the cluster projects and between members and R&D institutions. There is further reason to assume that this collaboration contributes to more innovation than would otherwise have been the case, although this requires a separate analysis.

Increased innovation activity

We have no data that can directly measure the extent of firms' innovation activity before and after enrolment in a cluster project with support from the cluster program. However, the development in number of R&D projects with support from the Norwegian R&D tax credit scheme SkatteFUNN is closely linked to changes in firms' innovation projects. SkatteFUNN intends to stimulate R&D within all industries. All firms with an approved innovation project are eligible for tax credit. Thus, with an actual innovation projects there is no reason not to apply for tax credit.

We do find that the cluster members in our sample have higher growth in innovation projects within the SkatteFUNN scheme, than other firms. However, it is not clear whether this can be attributed to the cluster participation.

Significant economic growth

Comparing cluster members in our sample with a matched control group, we find significant positive effects on employment, sales revenues and value added the first three years after enrolment in a cluster project. We do not find a significantly

higher growth among the cluster members in the second three-year period after enrolment.

Our econometric results are in line with what we would expect from the theory of public support of clusters, the rationale for Norwegian Innovation Clusters and previous evaluations of effects on firm performance of participation in the Norwegian cluster program.

Our interpretation of the results is that the cluster projects trigger unresolved dynamic processes in the respective cluster projects.

Based on the above, it is our clear recommendation that Norwegian Innovation Clusters continue to support both new and existing cluster projects. However, it is our interpretation that the cluster projects primarily have a “kick-off” effect. Thus, we recommend a more limited period of public funding of cluster projects than today, e.g. termination of Arena projects after three years and NCE projects after seven (3+4) years.

Positive changes in organisation and operation

With the implementation of Norwegian Innovation Clusters (NIC) and in the years after, several organisational changes have been made. We consider these as a professionalisation of the operation of the program and as an efficiency improvement.

Compared to the number of firms supported, the programs' annual budget is relatively modest. Given our results on firm performance from participating in a cluster project, we find that the additional value added exceeds the program's social costs after only two years.

Despite mostly positive organisational changes, one challenge remains. The cluster program is

not clear on how public funding of different cluster projects should or will be tended. That is, the exit strategies are unclear.

It is our assessment that the program will benefit from making it clear from start that funding beyond the agreed number of years is impossible at NCE level, and only exceptionally for Arena clusters. Our recommendation to not allow for continuation after an ended NCE project follows our assessment of GCE.

The three existing GCE projects have clearly shown that they initiate many relevant activities that are likely to be important for the further development of the clusters, and - not least - have been very important for the conversion process of the clusters. The latter has been important because the current GCE clusters are very closely linked to rapid restructuring of the oil and gas sector. However, we have not been able to find theoretical arguments for supporting cluster projects beyond the 10 years of support possible within NCE.

When we ignore the GCE clusters' (important) conversion efforts it is only the development of common goods, as enhancing their knowledge infrastructure, that really justifies the long-term support, but this can be supported through other, more targeted schemes.

Alternative use of funds

Though we do not find support of long-term funding of cluster organisations in themselves, our evaluation reveals a need for more long-term support in situations where cluster organisations initiate larger common good projects that are of a size and complexity that takes a long time to realise. Examples of such common good projects are development of new knowledge or research

institutions and test or laboratory facilities available for the whole cluster.

It is our assessment that both established and new clusters, outside or within the cluster program, can help revealing which knowledge infrastructures that do not work optimally and what can be gained by establishing a long-term collaborative project to strengthen these public goods. If Norwegian Innovation Clusters establishes application-based funding schemes for such activities, the cluster program will help promote activities that firms can rarely promote on their own.

The advantage of restricting eligible applicants to clusters (within our outside of the cluster program), that can document their organisation, is that it increases the likelihood that the project will be relevant to a large group of firms that have exposed their growth potential. Over time, it will probably be the clusters who continuously work to strengthen the dynamics of their own cluster that will win in such application-based competitions.

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1 Introduction

Localisation of industries have several explanations. However, the main explanations throughout history have been physical conditions, such as climate conditions and quality of the soil, existence of mines and quarries, or within easy access by land or water (Marshall 1920). The benefits of industry agglomeration ultimately reflect gains that occur when proximity reduces transport costs, such as costs of moving goods, people and ideas (Ellison, Glaeser and Kerr 2010).

Innovation takes place in interaction between people, organisations and businesses. Individual companies can, however, hardly keep track of, hold or deal with all relevant knowledge and are consequently dependent on interaction with other companies and research institutions (St.meld. nr. 20 (2004-2005)).

Information and knowledge spillovers can give clustered firms a better production function than isolated producers (Krugman 1991a). Thus, countries seek to strengthen or replicate the success factors that have encouraged the concentration of innovative firms associated with the knowledge economy. A clear rationale for public support of clusters concerns the transaction costs and coordination costs to bring the appropriate actors together (OECD 2007).

Several public schemes aimed at networks and clusters are intended to facilitate knowledge spillovers between firms and research and education institutions. They include a variety of activities justified in theories of how innovation takes place in interaction between different actors (Meld. St. 27 (2016-2017)).

Cluster policies are an expression of political commitment and set of specific government policy interventions aiming at strengthening existing clusters or facilitating the emergence of new ones. Modern cluster policies aim to put in place a favourable business eco-system for innovation and entrepreneurship in which new winners can emerge and thus support the development of emerging industries (European Commission 2015).

Norway has had a strategy to strengthen industry clusters through a national cluster program since the beginning of the 2000s. The Arena program was launched in 2002 and has since supported nearly 70 cluster projects. Norwegian Centres of Expertise (NCE) was launched in 2006 to further strengthen interactions in the Norwegian innovation system. NCE has supported 14 projects. In 2014, Arena and NCE were merged into one program; the Norwegian Innovation Clusters program. At the same time, Global Centres of Expertise (GCE) was initiated as a third level. GCE supports three cluster projects.

1.1 Evaluation of the program

Innovation Norway, the Research Council and Siva¹ have commissioned this evaluation of the Norwegian Innovation Clusters program as well as an evaluation of the following seven completed cluster projects:

- Arena Biotech North
- Arena Lønnsomme vinteropplevelser
- Arena Smart Water Cluster
- NCE Instrumentation
- NCE Micro- and Nanotechnology
- NCE Raufoss
- NCE Systems Engineering

¹ The Industrial Development Corporation of Norway

The government has expressed a desire to develop the current cluster policy. Different schemes intended to increase innovation and value creation through stimulating collaboration in clusters are managed by different agencies and need to be seen in context. They also need to be seen in context with other innovation and research schemes (Meld. St. 27 (2016-2017)).

As set out in the agreements between the cluster program and the individual cluster projects, there should also be conducted external evaluations of each completed project.

The main objective of this evaluation is to assess to what extent the program meets the needs of the target group, whether the operation and organisation of the program is appropriate and whether the effects are in accordance with the objectives.

The evaluation is organised according to OECDs criteria for evaluating development assistance.² That is, the evaluation is structured around three main criteria: relevance, effectiveness (incl. impact) and efficiency.

This evaluation will assess the following:

- To what extent the market or system failure constituting the rationale for the program is still present and if and what alternative measures that exist to compensate for these failures (relevance).
- Whether the cluster projects have achieved their stated objectives and whether they collectively contribute to achieving their program level's objective and the cluster program's common objectives (effectiveness).

- Organisation and operation of the cluster program, including an assessment of whether changes in organisation and operation has contributed to the program's relevance, effectiveness and efficiency.

To assess the abovementioned, we have reviewed program and project descriptions, relevant policy documents and research papers and previous evaluations. Further, we have interviewed relevant stakeholders, participating firms in the seven clusters subject for evaluation as well as the project manager in each of the seven clusters.

We have analysed effects in firm performance from participating in a cluster project by comparing growth in selected performance indicators (e.g. employment, revenues and productivity) for core members in the clusters with growth in similar firms not participating in a cluster project.³

In addition, we have mapped firms' R&D network by analysing their R&D collaboration in projects with public funding. Data and the empirical concept is described in more detail below.

1.2 Outline of the report

The following chapter gives a thorough presentation of the cluster program and briefly describes the seven cluster projects subject for evaluation. These are described in more detail in separate reports.

Chapter 3 describes the theoretical foundation of cluster programs both internationally and in Norway and assess whether the current Norwegian program can be justified in theory.

² <http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.html>

³ That is applying a matched difference-in-differences procedure.

Chapter 4 maps the interaction with other public schemes. Chapter 5 analyse network effects for the participating firms. Chapter 6 analyses the effects of participation in a cluster project on firm performance. Chapter 7 discusses the clusters' regional ripple effects. These chapters cover the assessment of the program's effectiveness.

Chapter 8 assesses the organisation and operation of the program, whereas Chapter 9 assesses the program's costs. Chapter 10 presents selected international cluster programs.

We conclude with the main results, their implications and policy recommendations in chapter 11.

2 The Norwegian Innovation Cluster program

The program Norwegian Innovation Clusters (NIC) was launched in 2014. The program is a continuation of the Arena program launched in 2002 targeting immature clusters and Norwegian Centres of Expertise (NCE) launched in 2006 targeting mature clusters with a national position. With the introduction of NIC it was also introduced a third, and new level, Global Centres of Expertise (GCE) targeting mature clusters with a global position.

Norwegian Innovation Clusters aims to promote and enhance collaboration activities in clusters. The government support the cluster activities by financing cluster facilitators and common activities in each cluster within the framework of the program. The goal is to increase the cluster dynamics and attractiveness, the individual company's innovativeness and competitiveness.⁴

2.1 The prelude to the current cluster program

In a report from 2002 the Ministry of Trade and Industry⁵ discussed the need for a renewal of governmental funded industrial policy schemes.⁶ The report discusses, among other things, the trade-off between industry-neutral schemes and schemes targeting selected industries, technologies and fields of knowledge. The report concludes that the principles of neutrality should be maintained, but practiced more flexibly than before and that this can be achieved by prioritising efforts towards clusters or industries in an early development phase.

“(...) A public contribution to the development of clusters can, among other things, secure clusters that otherwise would not have been developed and

help establish a sustainable critical mass. Developing clusters seems to be of great importance for value creation and the localisation of foreign businesses in Norway. It is therefore desirable to contribute to the development of both new and existing clusters and business environments in Norway.”

The report addresses the challenge of choosing policy instruments that effectively contribute to promoting key business environments, without making the effort ineffective and preserving existing industry structure. However, it was emphasised that *“the most important thing is that the programme targets cluster mechanisms to promote knowledge transfers, increased interaction, collaboration, networking and learning.”*

These ideas and references to theory first constituted the rationale for Arena and later NCE, which started as two separated programs with similar objectives, but different target groups (see below). The establishment of NIC in 2014 continued the basic ideas and objectives of the two programs, but included Arena and NCE as levels in a common cluster program.

The change in the program structure came as a result from earlier evaluations of the Arena program (Jakobsen, Iversen, et al. 2011) and the NCE program (Econ Pöyry and Damvad 2011). Jacobsen and Røtnes (2011) summed up these evaluations and recommended that the two existing cluster programs should be continued and scaled up. Further, the evaluation of NCE suggested that a stronger and more formal link between Arena and NCE would contribute to a significant simplification and improvement in selecting new NCE projects.

⁴ <http://www.innovationclusters.no/english/>

⁵ Merged into Ministry of Trade, Industry and Fisheries on January 1st, 2014

⁶ <https://www.regjeringen.no/no/dokumenter/virkemidler-for-morgendagens-naringsliv/id105778/?q=en%20helhetlig%20innovasjonspolitikk>

Reve and Sasson (2012) later argued that there was a need for a third level in the range of network programs, and suggested that a so-called Global Centre of Expertise should be introduced. The reasoning for the proposal was that industry clusters with ambitions to develop better knowledge dynamics will normally start at Level 1 (Arena), then qualify for Level 2 (NCE), but that the network development should not end there. Hence, the suggested Level 3 (GCE), where the number of firms in the network should be expanded, number of knowledge links increased, with collaboration between several NCE clusters and where the network establishes links to global partners.

In June 2012, a project group, appointed by the board of owners for Arena and NCE, was commissioned to develop a framework for a new, comprehensive cluster program. The project group consisted of representatives from the owners of Arena and NCE; Innovation Norway, the Research Council of Norway and Siva. They submitted their proposal, including a possible framework for Global Centres of Expertise as a third level, to the board in October 2012, who approved the proposal.

Innovation Norway, the Research Council and Siva sent their input on a new cluster program to the Ministry of Trade and Industry and the Ministry of Local Government and Modernisation in March 2013. The proposed framework for new program was finalised in the first program description dated June 10th, 2013, where a new offer for mature clusters with a global position was introduced; Global Centres of Expertise.

It was allocated a budgetary increase to the new cluster program in the National Budget for 2014 and

Norwegian Innovation Clusters was implemented through a call for proposals and selection of new clusters projects the first half of 2014.

2.2 Stakeholders and organisation⁷

Norwegian Innovation Clusters is jointly owned by Innovation Norway, the Research Council of Norway and Siva. This implies that all strategic decisions regarding the program's development, involvement in cluster projects and monitoring of these are taken jointly by the three owners. A team from Innovation Norway and advisors from the Research Council and Siva are responsible for the program's operational activities.

The program is funded by the Ministry of Trade, Industry and Fisheries and the Ministry of Local Government and Modernisation.

It is established an *advisory board* to ensure a solid foundation of the program. The council consist of eight representatives from different industries, knowledge institutions and regional development agencies, as well as the three abovementioned owners. The council advises the owners on the program's strategic development and dispositions, including which cluster projects should be included in the program and approval of extensions or discontinuation in cases where the project is assessed to no longer be eligible for public funding.

Innovation Norway has the main operational responsibility, including managing grants and contracts with the cluster organisations (beneficiaries). That is, formal decisions regarding financing and contractual terms are taken by Innovation Norway, who also reports on the program's activities to their

⁷ This and the next paragraph is based on the third program instruction, dated January 12th, 2016.

owners and financiers. Further, there is a program management in Innovation Norway that develops strategies for the program, which are approved by the program owners.

The main responsibility for administration and management of the program lies with two *program managers*, one for Arena and one for NCE/GCE, both employed in Innovation Norway. The program managers work as sparring partners and oversee the monitoring of cluster projects in line with the agreements between the program and the individual cluster project.

Innovation Norway's regional offices allocates an *account manager* to each cluster project. The account managers offer advice and guidance during the application process and are responsible for funding and payments throughout the project period, as well as monitoring the projects' progress and serve as strategic advisors.

The Research Council is responsible for developing the program and cluster projects' engagement in R&D initiatives. The Research Council's regional representatives also participate in the ongoing dialogue with the cluster projects.

Siva is responsible for developing the program and cluster projects' engagement to enhanced innovation efforts, especially through incubation.

2.3 Selection of cluster projects

The program has normally an annual call for new projects. The program is implemented as a national program. That is, all new cluster projects, at all levels, are assessed according to national criteria and procedures.

2.3.1 Requirements for applicants and application

There are no restrictions on who can apply for admission in the cluster program. But, applicants for all levels (see detailed description below) must meet a set of requirements for how the cluster project is organised, e.g. a legal entity as formal applicant, a defined partnership between actors in the cluster, a board representing the partnership and an operational management.

The project proposal must be in accordance with the purpose of the program and the specific call for proposals. Further, it should be a result of a joint process with participation from key actors in the partnership.

2.3.2 Selection criteria

The selection criteria are specific for each program level and stated in detail in the specific calls for application. However, they are all structured according to the following main questions:

A. The cluster's resources and position (baseline)

1. Cluster resources: Does the cluster have a composition of stakeholders and collaborative foundation that provides as basis for collaboration-based innovation and development of the cluster and its participants?
2. The cluster's position and potential: Does the cluster have an established position and potential for further growth that can be utilised for increased innovation and value added?

B. The quality and relevance of the cluster project

3. The cluster project's objectives, strategies and potential impact: Does the cluster project have a strategic idea that can help

achieve the objectives of innovation and value creation?

4. Ownership and leadership: Does the cluster project provide a necessary foundation among participants and a professional leadership that can help trigger strategic collaboration activities?
5. Plan for implementation: Does the cluster project have a well-developed plan for implementation and resource base that can provide the basis for effective and targeted implementation?

2.3.3 Selection procedure

Project proposals are assessed in accordance with specified procedures explained in the individual calls. The selection of new cluster projects will normally be conducted in two stages: (i) potential applicants submit sketches (mandatory) which provides the basis for a first feedback and (ii) applicants submit complete applications for assessment and decision.

The sketch must include information about the level at which it is applied, applicant information and information that makes it possible to assess the project according to the questions above (e.g. the project's objectives and the cluster's relational prerequisites). The complete application should be an elaboration of the submitted sketch.

A group of independent external experts evaluate the applications, whereas complementary assessments, such as interviewing applicants, are conducted by the program management. Further, the board of owners conduct a decision in principle of new cluster projects.

Cluster projects included in and funded by the program enters into agreements governing the relationship between the program and the project.

2.4 Three different program levels

Norwegian Innovation Clusters support cluster projects on three levels. These levels differ from each other in two important areas; (i) *target group* and (ii) *duration of support*.

Arena targets immature clusters and the projects are supported for a period of three to five years. NCE targets mature clusters with a national position, whereas GCE targets mature clusters with a global position. NCE and GCE supports projects for 10 years.

Each cluster project establishes its specific objectives, based on the clusters established position and prerequisites for further development (in accordance with selection criteria mentioned above) and the specific objectives for the individual program level (cf. table 2.1). As is evident from the stated impact and output targets, the main difference between the three program levels is that the requirements for achieving the objectives reflect higher aspirations.

In the following the different program levels are presented in more detail.

2.4.1 Arena

The Arena program was established in 2002 based on experiences from a series of regional pilot projects in the period before 2002. It is intended to increase firms and industries' ability for innovation, through increased and enhanced collaboration.

Arena targets clusters of newly established and/or immature collaboration initiatives, with an organisation, strategic platform and a resource base that provide a good potential for further growth based on collaboration. Arena clusters can be relatively small

and primarily have a regional position, or be larger with a national position.

apply for extension are assessed according to the following criteria:

Arena offers financial and professional support to cluster projects with a duration of three years (phase 1). In addition, there is an opportunity to apply for a two-year extension of the project (phase 2). A status assessment is conducted after three years to assess the grounds for extension. Projects that

1. Effectiveness (performance) during first three years
2. Implementation, ownership and leadership during first three years
3. Potential for further results and effects if the project is extended

Table 2.1

Objectives for cluster projects at the individual program level

Impact targets			
	Arena	NCE	GCE
	Increased ability for innovation	Increased value creation within the cluster	Increased value creation and attractiveness and a position within global value chains
Output targets			
	Arena	NCE	GCE
Innovation skills	Increased innovation collaboration and innovation activity	Increased innovation activity through systematic collaboration between firms and R&D institutions	Increased innovation activity with a significant impact within radical innovation processes
International orientation	New or enhanced relationships with international partners	Increased collaboration with international partners	Increased strategic collaboration with leading international partners
Access to competence	Better access to relevant competence	Better access to relevant competence through strategic collaboration with educational institutions	Better access to relevant competence through strategic cooperation with leading national and international educational institutions
Attractiveness and visibility	Increased regional recognition as an innovative and sustainable environment	Increased recognition as a nationally important environment for innovation and growth	Increased recognition as a hub or node in a global innovation system
Interaction and collaboration	Increased dialogue and collaboration internally and externally	Increased targeted collaboration internally and externally	Increased strategic collaboration internally and externally

Source: Program description Jan. 12th, 2015

4. Objectives, strategies plan for implementation for the next two-years period

Arena projects are subject for external evaluation at the end of the project period.

Arena clusters may apply for participation at the next level (NCE) during the project period. Approval of the application implies that the current agreement is terminated and replaced by a new agreement in accordance with requirements at the new level.

Arena has supported around 70 cluster projects since the establishment in 2002 and currently supports 18 cluster projects (see list of projects and their characteristics below).

2.4.2 Norwegian Centres of Expertise

Norwegian Centres of Expertise (NCE) was established in 2006 based on prior analyses and inspiration from other countries. NCE is intended to focus, improve and accelerate already on-going development processes in clusters that have established systematic collaboration, with potential for growth in both national and international markets.

NCE targets clusters with an established organisation with well-developed services, partners with experience and achieved results from collaboration projects, well-established national position and further national and international growth potential.

NCE offers financial and professional support to cluster projects with a duration of five years. If the cluster project is recruited directly into NCE (not following an Arena project), it may apply for a second contract period of five years. If the cluster started

out as an Arena project, the years in Arena is deducted, so that the project period does not exceed 10 years. A status assessment is conducted after two years, and after seven years if the project is extended. NCE projects are subject for external evaluation after five years to assess the grounds for extension, and at the end of the project period.

NCE clusters may apply for participation at the next level (GCE) during the project period. Approval of the application implies that the current agreement is terminated and replaced by a new agreement in accordance with requirements at the new level.

NCE has supported 15 cluster projects since 2006, of which 11 are currently active (see list of projects and their characteristics below).

2.4.3 Global Centres of Expertise

Global Centres of Expertise (GCE) was introduced in 2014 with the establishment of Norwegian Innovation Clusters (see discussion above). GCE is intended to increase value creation and attractiveness in clusters with a considerable potential for growth in both national and international markets.

GCE targets clusters with a well-functioning organisation, a critical mass of partners with high interaction in a broad strategic area of activity, anchored in a well-functioning innovation system, and with a well-established position within global value chains. Due to state aid rules, GCE does not offer financial support for cluster development (operational activities)⁸, and there are thus no formal limitations on maximum time horizon for the projects. However, the current cluster program limits GCE projects to

⁸ The EEA agreement limits the possibilities Norwegian authorities have for providing support for business activities. Financial support for operating activities to the legal entity that operates a cluster can be granted for five years with an aid intensity that is either linearly decreasing from 100 to 0

pct. throughout the project period, or fixed at 50 pct. over a five-year period. Support may be granted beyond five years and up to ten years if the need for this is sufficiently documented (Fornyrings-, administrasjons- og kirkedepartementet 2010).

maximum 10 years. GCE offers financial support to increase and enhance knowledge, innovation and cluster-to-cluster collaboration (see below). GCE follows the same evaluation routines as NCE.

GCE supports three cluster projects, all of which have been NCE clusters.

2.5 Funding of cluster projects

Norwegian Innovation Cluster offers partial funding of cluster projects through annual grants to activities organised by the cluster management. Financial support given through the cluster program is intended for activities considered strategically important to realise the purpose of the given cluster project.

2.5.1 Strategic priorities and eligible activities⁹

Funded activities should be based on the cluster project's strategy, collaboration between several partners or participants and have openly available results. All costs funded by the cluster program should be linked to activities in the following four strategic priorities:

- A. General cluster development: The purpose is to carry out basic services within the cluster, i.e. managing and developing the cluster based on efforts from the contractor, project manager and participants in the cluster.
- B. Knowledge collaboration: The purpose is to establish and strengthen collaboration between participants in the cluster and R&D&I and educational institutions, both nationally and internationally.
- C. Innovation collaboration: The purpose is to contribute to more and faster initiated R&D&I-based collaboration projects in the cluster and technology dissemination linked to these projects.
- D. Cluster-to-cluster collaboration: The purpose is to initiate and reinforce strategic alliances with other clusters to establish research and innovation collaboration between firms in the clusters and knowledge institutions.

Table 2.2

Examples of activities eligible for support from the cluster program

Strategic priorities and activities	
A General cluster development	<ul style="list-style-type: none"> Facilitation of collaboration and information sharing Management of cluster facilities Analytical processes to develop the cluster's activities Promotion of the cluster Organisation of training, networks and meeting places
B Knowledge collaboration	<ul style="list-style-type: none"> Explore, establish and reinforce links to R&D institutions Strategic collaboration with educational institutions Apply and disseminate new knowledge
C Innovation collaboration	<ul style="list-style-type: none"> Early stage innovation projects Technology dissemination linked to R&D activities Establish technical and intangible infrastructure
D Cluster-to-cluster collaboration	<ul style="list-style-type: none"> General networking and dialogue Establish strategic partnerships Develop collaboration in SME groupings

Source: Program instruction dated Jan. 12th, 2016

The objectives under the latter three priorities include activities that arise from general cluster development (A). The activities (see examples in table 2.2) are organised as subprojects conducted in collaboration between cluster participants, with support

⁹ This paragraph is based on the third program instruction, dated January 12th, 2016.

from the project manager (of the cluster project) where it is needed.

The main principles for eligible cost are the contractor/project manager's personnel and administrative costs (A), personnel costs etc. for project participants (B-D) and costs for advisory services etc. (D).

Arena and NCE can support activities within all strategic priorities from A to D above, whereas GCE can only support activities from B to D.

2.5.2 Annual budget

The cluster program had a budget of about NOK 143 million for cluster projects in 2016. Including administrative costs, the total budget was approximately NOK 166 million (Innovation Norway 2016). Compared to the years prior to the establishment of Norwegian Innovation Clusters, except for 2009¹⁰ and 2012¹¹, there has been a significant increase in the cluster program's annual budget (cf. figure 2.1). This is due to the introduction of GCE, which has larger budgets per project, and an increase in the number of cluster projects. With the increase in number of cluster projects, and mainly Arena projects, the average project size has decreased (cf. figure 2.2).

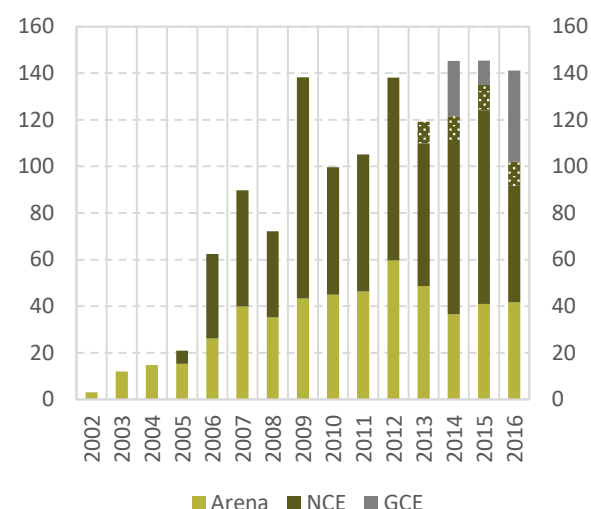
The size of the annual grants is determined by the cluster project's format, level of activity and the program's financial resources. Further, the grant is differentiated for the three program levels and will normally be within the following limits:

- Arena: NOK 1.5-3 mill. pr. year
- NCE: NOK 4-6 mill. pr. year
- GCE: NOK 8-10 mill. pr. year

¹⁰ The increase in 2009 is mainly due to time displacements of NCE projects in previous years and the lag from 2008 is largely retrieved in 2009 (Innovation Norway 2009).

Figure 2.1

Total funding of cluster projects.¹ NOK million. Constant 2016-prices. 2002-2016

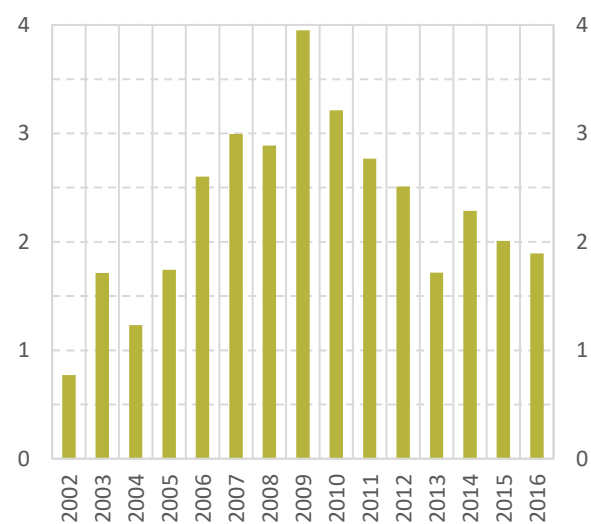


Source: Samfunnsøkonomisk analyse

1) The dotted area indicates grants to NCE clusters via Innovation Norway's scheme 1022 (see explanation below)

Figure 2.2

Average funding per cluster project.¹ NOK million. Constant 2016-prices. 2002-2016



Source: Samfunnsøkonomisk analyse

1) Excl. 1022 (development funding for NCE)

¹¹ The increase in funding of Arena projects 2012 is mainly due to time displacements of in previous years and transferred funds from 2011 (Innovation Norway 2012).

2.5.3 Self-financing and other funding

The cluster program mainly finances up to 50 pct. of the total cost of eligible activities. The remaining should be funded by members of the cluster in form of cash payments (member fees), or hourly effort and direct expenses (connected to implemented projects).

In addition to the program specific funding from the Ministry of Trade, Industry and Fisheries and the Ministry of Local Government and Modernisation (managed by Innovation Norway), the cluster program has allocated funds from the Ministry of Trade, Industry and Fisheries to a line of credit for cluster projects, the so-called “Innovasjonsrammen” since 2013 (cf. scheme 1022 in figure 2.1).

The purpose of “Innovasjonsrammen” is to stimulate innovation through more collaboration between firms. Both present and former cluster projects in the cluster program can apply for these funds. If granted, the clusters can prioritise which projects, within the cluster, to support themselves and these funds are thus more flexible than the program specific funding (A-D).

A cluster project may also receive funding from other public sources than Innovation Norway, e.g. municipalities or county municipalities. If this funding is channelled to the same activities as the funding from the cluster program (via Innovation Norway), this must be included in an overall budget for these activities and be in line with the requirements for maximum public funding. Additional funding of cluster projects must not be confused with the public funding individual members may receive (see Chapter 4).

2.6 Professional services¹²

In addition to the abovementioned funding, the program offers professional services to the clusters. This includes services aimed at developing a well-functioning cluster organisation with qualified facilitator, a network of relevant contacts and partners, and with a visible profile. The professional services are based on the program’s own experiences and relevant experiences from related activities; theoretical perspectives, policy perspectives etc. The program’s professional services include:

- a. Competence services: Upgrade the cluster organisation’s insight and skills to develop, manage and carry out cluster activities
- b. Advisory services: Develop the clusters’ strategic organisation (offer counselling from external advisors)
- c. Networking services: Develop and strengthen the clusters’ contact and collaboration with external actors that can help develop the cluster
- d. Promotional services: Market and promote the clusters as important hubs for innovation and value creation

These services are channelled to the clusters through gatherings, seminars, study tours, conferences etc.

2.7 Termination of cluster projects (exits)

In the final phase of the project the project facilitator (manager) must plan how the cluster (collaboration) will continue without funding from the program. This is referred to as the project’s exit strategy. There must be a plan for termination or continuation no later than six months before the contract with the

¹² This paragraph is based on the third program instruction, dated January 12th, 2016.

cluster program expires, e.g. both Arena and NCE clusters may apply for participation at the next level during the project period. An exit strategy is needed even when no continuation of the project is planned.

There are currently three GCE clusters. All three are former NCE clusters. Four other NCE clusters have reached the maximum 10 years of funding, but are not continued as GCE. However, several of these have participated in pilots for other publicly funded programs targeting clusters or business environments, such as Innovations Norway's "*Clusters for conversion*" (Klynger som omstillingsmotor) and Siva's "*Norwegian Catapult*" (Norsk katapult).

The abovementioned programs are not designed to be continuations of the cluster projects as such, but they target leading clusters and mature business environments, and thus represent a possible path for cluster projects that are or have been part of the cluster program. As both programs have come up in our interviews with cluster managers, which we will pursue in our recommendations, we give a brief presentation of the two programs in the following paragraphs.

2.7.1 Clusters for conversion

Innovation Norway launched the pilot "Klynger som omstillingsmotor (KOM)" in the autumn of 2015. The pilot focused on (i) *increased productivity and innovation* and (ii) *digitalisation*. The former was managed by Kongsberg Innovation (NCE Systems Engineering) and SINTEF Raufoss Manufacturing (NCE Raufoss), the latter by Smart Innovation Østfold (NCE Smart Energy Markets).

KOM aims to strengthen what already works in the leading clusters and make this available for firms outside the clusters across the country. The idea is that the clusters' expertise will boost the overall innovation and conversion rate. Applicants can be one or more established clusters or a consortium with partners from different clusters and business environments.

Experience from the pilot show that the clusters' expertise can contribute to faster conversion in SMEs outside the clusters in a cost-effective manner (Innovation Norway 2016).

Innovation Norway implemented "Clusters for conversion" in 2017¹³ and emphasises that the scheme must be seen in relation with "Norwegian Catapult".

2.7.2 Norwegian Catapult

Siva launched "Norwegian Catapult" in the spring of 2017.¹⁴ The scheme is intended to strengthen national infrastructure for innovation and thus contribute to a faster, cheaper and better development of ideas from the conceptual stage to market introduction. The establishment of catapult centres (pilot plants) will enable firms to test, simulate and visualise technologies, components, products, solutions and processes.

Norwegian Catapult targets applicants (a legal entity) with a strong connection to dynamic business environments, and has the capacity and ability to develop a centre in line with the purpose of the scheme.

¹³ Innovation Norway appointed two groups to raise the level of knowledge and help small and medium-sized businesses across the country exploit new business opportunities in the digital transformation on November 1st,

2017. NCE Raufoss and GCE Subsea is part of one group and Arena iKuben, Smart Innovation Norway (managing NCE Smart Energy Markets) and NCE Systems Engineering the other group.

¹⁴ Siva appointed two catapult centres on October 20th, 2017. NCE Raufoss host one and NCE Eyde is part of the other.

A dynamic business environment means an environment with established venues to meet, collaborate and share expertise for at least a dozen firms with a well-established position in global value chains. In general, the environment should have a well-functioning innovation system, a good international network, and established collaboration with R&D environments, both nationally and internationally.¹⁵

2.8 Cluster characteristics

There is a total of 47 cluster projects included in the current evaluation (see list of projects in table 2.4). Of these are 29 Arena projects, 15 NCE projects and three GCE projects. The first projects started in 2005, whereas the latest started in 2016. If we do not distinguish between type of membership or degree of involvement, these clusters have included almost 2 600 members.

However, most clusters divide their members in four groups; core businesses, other active firms, R&D and educational institutions and public development actors. It appears that there are different practices among the clusters of how they categorise their members, especially when distinguishing between core members and other active firms. In the presentation of different cluster characteristics and in the econometric analysis (Chapter 4), it has been necessary to refine the selection of core members in a more consistent matter.

2.8.1 Core members

Our definition of core members is based on the list of participants categorised as “core businesses” and “other active firms”. In accordance with previous evaluations of effects of participation in a cluster project, we have chosen to limit the selection of core members to limited liability companies (LLC).¹⁶

Table 2.3
Number of core members per cluster level by enrolment year. 2005-2016

Enrolment year	Arena	NCE	GCE ¹	Total
2005			23	23
2006		51	22	73
2007		8	8	16
2008		3	7	10
2009		23	21	44
2010	31	15	28	74
2011	61	46	12	119
2012	97	31	10	138
2013	42	55	13	110
2014	90	28	9	127
2015	71	75	11	157
2016	107	59	11	177
Total	499	394	175	1 068

Source: Samfunnsøkonomisk analyse

1) All GCEs were previously NCEs. They are categorised as GCE throughout the entire data period

Further, we have limited the selection of core members in each cluster to LLCs located in the economic region¹⁷ we consider to be the cluster's geographic localisation (see next paragraph). As we want to focus on firm performance, we have chosen to exclude research institutes organised as limited liabilities.

¹⁵ <https://siva.no/norsk-katapult/beskrivelse-av-ordningen/>

¹⁶ The econometric analysis presented in chapter 4 largely follows the method used in yearly evaluations of effects on firm performance of support from Innovation Norway (Cappelen, et al. 2015). Further, to study effects on and development in number of employees, value creation, productivity, etc. it is a prerequisite that the cluster members are present in accounting data. All LLCs are liable for accounting and by refining the

selection of core members to these firms we ensure that we have the necessary information on all firms in our sample.

¹⁷ Economic region is a regional classification for the level between county and municipality. The main criteria used for defining the regions are labour market and trade. The classification corresponds to the NUTS 4-level in EU's regional classification.

Table 2.4

Cluster projects included in the evaluation (highlighted clusters are subject for individual evaluations)

Cluster project ¹	Economic region ²	Main industry ³	Members ⁴
Arena Arktisk Maritim Klynge (2013-)	Harstad	50 Water transport	10 (10)
Arena Arktisk Vedlikehold (2014-)	Hammerfest	52 Support activities for transportation	5 (8)
Arena Biotech North (2012-2016)	Tromsø	72 Scientific research and development	29 (21)
Arena Blue Legasea (2014-)	Ålesund	10 Food products	18 (13)
Arena DesignArena (2012-)	Bergen	74 Other prof., scientific, techn. act.	45 (31)
Arena Digin (2009-2015)	Kristiansand	62 Computer programming, consultancy	20 (39)
Arena Electric Mobility Norway (2011-2015)	Drammen	35 Electricity, gas and steam	13 (7)
Arena Heidner (2012-)	Hamar	72 Scientific research and development	7 (13)
Arena i4plastics (2014-)	Gjøvik	22 Rubber and plastic products	12 (7)
Arena iKuben (2011-)	Molde	71 Architecture, engineering activities	26 (25)
Arena Innovasjon Torsk fisk (2015-)	Vesterålen	10 Food products	14 (14)
Arena Lønnsomme vinteropplevelser (2011-2016)	Tromsø	79 Travel agencies, tour operators	20 (22)
Arena Mineralklynge Norge (2012-)	Mo i Rana	07 Mining of metal ores	23 (5)
Arena Norwegian Fashion Hub (2014-)	Oslo	46 Wholesale trade	34 (15)
Arena Norwegian Rooms (2013-)	Ålesund	31 Furniture	15 (14)
Arena Norwegian Smart Care Cluster (2014-)	Stavanger	62 Computer programming, consultancy	31 (46)
Arena Nxt Media (2012-2015)	Trondheim	62 Computer programming, consultancy	9 (15)
Arena Ocean of Opportunities (2011-2014)	Stavanger	03 Fishing and aquaculture	9 (8)
Arena Olje- og gassklynge Helgeland (2015-)	Mo i Rana	25 Fabricated metal prod.	45 (13)
Arena Oslo Edtech Cluster (2016-)	Oslo	62 Computer programming, consultancy	30 (17)
Arena Skognæringa i Trøndelag (2016-)	Levanger	02 Forestry and logging	14 (5)
Arena Smart Grid Services (2011-2014)	Steinkjer	62 Computer programming, consultancy	15 (10)
Arena Smart Water Cluster (2010-2016)	Steinkjer	25 Fabricated metal prod.	25 (17)
Arena Solenergiklyngen (2016-)	Oslo	46 Wholesale trade	8 (14)
Arena Subsea Valley (2010-)	Oslo	46 Wholesale trade	170 (44)
Arena Tunnel Safety Cluster (2016-)	Stavanger	74 Other prof., scientific, techn. act.	7 (29)
Arena Usus (2010-2015)	Kristiansand	55 Accommodation	97 (21)
Arena Vannklyngen (2011-2014)	Tønsberg	46 Wholesale trade	16 (7)
Arena Vindenergi (2010-2014)	Trondheim	71 Architecture, engineering activities	19 (10)
GCE Blue Maritime (2005-)	Ålesund	46 Wholesale trade	36 (53)
GCE NODE (2005-)	Kristiansand	28 Machinery and equipment	91 (38)
GCE Subsea (2006-)	Bergen	71 Architecture, engineering activities	92 (84)
NCE Aquaculture (2007-)	Bodø	03 Fishing and aquaculture	23 (6)
NCE Aquatech Cluster (2016-)	Trondheim	71 Architecture, engineering activities	79 (24)
NCE Culinology (2009-)	Stavanger	10 Food products	11 (13)
NCE Eyde (2007-)	Kristiansand	71 Architecture, engineering activities	14 (9)
NCE Instrumentation (2006-2016)	Trondheim	71 Architecture, engineering activities	65 (35)
NCE Maritime CleanTech (2011-)	Sunnhordland	30 Other transport equipment	20 (18)
NCE Media (2013-)	Bergen	62 Computer programming, consultancy	12 (70)
NCE Micro- and Nanotechnology (2006-2016)	Tønsberg	26 Electronic and optical products	33 (33)
NCE Oslo Cancer Cluster (2006-)	Oslo	72 Scientific research and development	28 (27)
NCE Oslo Medtech (2011-)	Oslo	62 Computer programming, consultancy	114 (88)
NCE Raufoss (2006-2016)	Gjøvik	25 Fabricated metal prod.	21 (31)
NCE Seafood Innovation Cluster (2015-)	Bergen	10 Food products	11 (5)
NCE Smart Energy Markets (2009-)	Halden	62 Computer programming, consultancy	31 (13)
NCE Systems Engineering (2006-2016)	Kongsberg	28 Machinery and equipment	8 (11)
NCE Tourism Fjord Norway (2009-)	Bergen	79 Travel agencies, tour operators	50 (11)

Source: Samfunnsøkonomisk analyse

1) First year of each cluster project is mainly set to the year we first observe members in data

2) Economic region with highest share of members (excl. R&D and educational institutions and public development actors)

3) The industry with the highest share of core members

4) Core members as categorised in the member lists versus core members defined as in paragraph 2.8.1 (in parentheses)

Our sample consists of a total of 1 068 core members. About 47 pct. are (or have been) members in an Arena cluster, 37 pct. a NCE cluster and 16 pct. a GCE cluster (cf. table 2.3).¹⁸ For most clusters included in the evaluation, our definition of core members reduces the number of participants compared to the categorisation in the member lists (cf. table 2.4).

The core members are relatively mature firms when they become members of a cluster project; approximately 12 years on average for NCE and GCE and 13 years for Arena. Measured in number of employees¹⁹, the core members are on average significantly larger than a typical limited liability (cf. table 2.5).

Table 2.5
Average number of employees per core member by cluster level. 2003-2016

Year	Core members				Others ¹
	Arena	NCE	GCE	All	Others
2003	71.2	87.4	43.9	74.6	12.0
2004	79.0	104.1	54.4	86.1	11.5
2005	78.8	101.2	57.4	85.1	11.6
2006	84.3	103.1	74.8	92.9	11.6
2007	91.0	114.1	87.3	102.1	12.0
2008	96.3	120.2	103.5	109.3	12.2
2009	93.4	120.0	100.1	106.2	12.0
2010	90.8	111.6	96.9	101.1	11.7
2011	91.5	110.6	96.9	100.8	11.9
2012	99.0	109.7	102.2	105.0	11.7
2013	92.3	102.4	108.2	99.7	11.5
2014	101.2	101.8	120.2	105.5	11.3
2015	99.1	100.8	119.9	103.8	11.0
2016	86.0	105.6	84.7	93.4	11.0
N	499	394	175	1 068	155 426

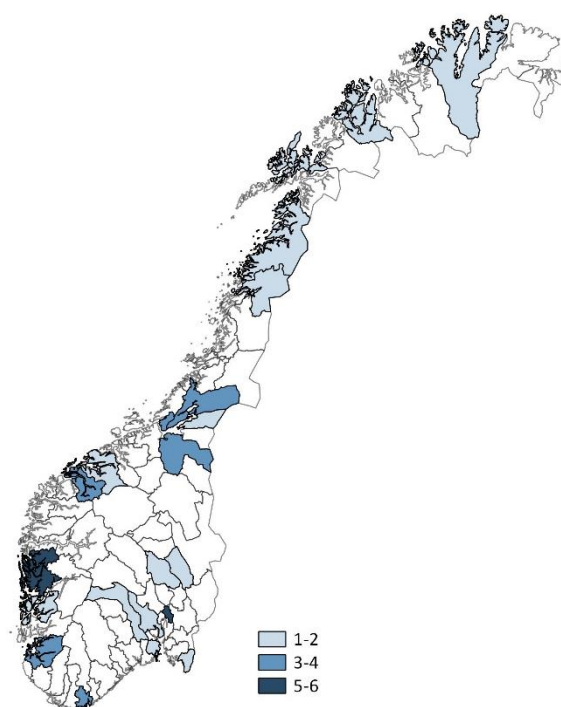
Source: Samfunnsøkonomisk analyse

1) LLCs never registered as member of a cluster project

2.8.2 Geographical distribution

Most clusters have members from several different regions. Nevertheless, one region usually stands out when counting members per region and can be considered as the clusters “headquarter”. When defining core members, we have chosen to define the cluster’s geographic localisation as the economic region where the largest share of members is located (excluding R&D and educational institutions and public development actors).

Figure 2.3
Number of cluster projects per economic region. 2005-2016¹



Source: Samfunnsøkonomisk analyse

Map: ©Kartverket

1) The 47 cluster projects included in the evaluation

¹⁸ Firms defined as a core member in more than one cluster project is counted once per project. However, with our definition, the cluster projects

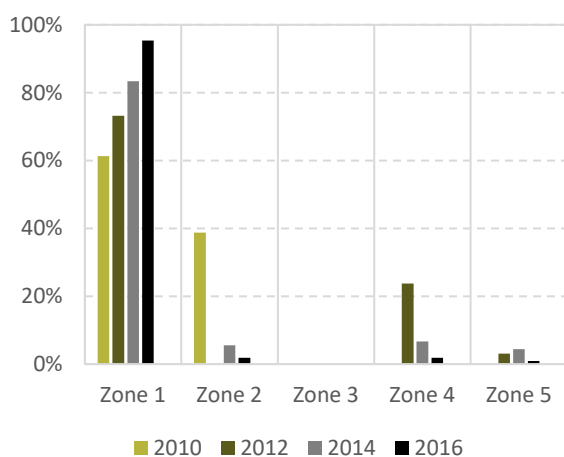
must be in the same economic region for this to happen. In the econometric analysis we keep only the first membership.

¹⁹ Employment is measured in number of full-time equivalents (FTEs).

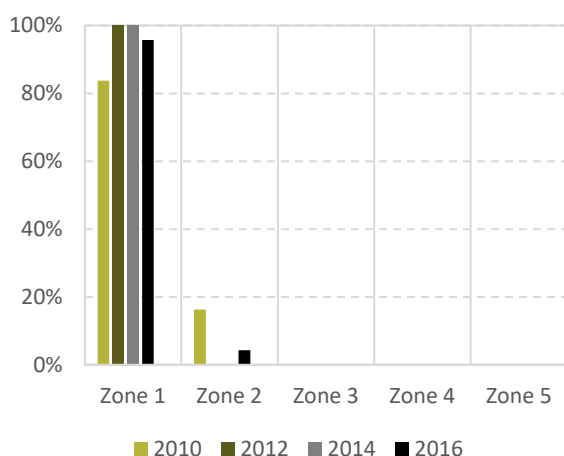
The cluster projects are located all over Norway but with variation in the number of projects per region (cf. figure 2.3). Arena targets cluster projects with a regional position and a significantly larger proportion of clusters at this level are in more rural regions, compared to NCE and GCE clusters which are all located in central regions. However, there is a tendency for a larger proportion of new Arena clusters to be in central regions (cf. figure 2.4).

Figure 2.4

Core members by labour tax zone and enrolment year.¹ Share of total. Arena



Core members by labour tax zone and enrolment year.¹ Share of total. NCE and GCE



Source: Samfunnsøkonomisk analyse

1) Zone 1 is the most central regions, Zone 5 the most rural

2.8.3 Industrial distribution

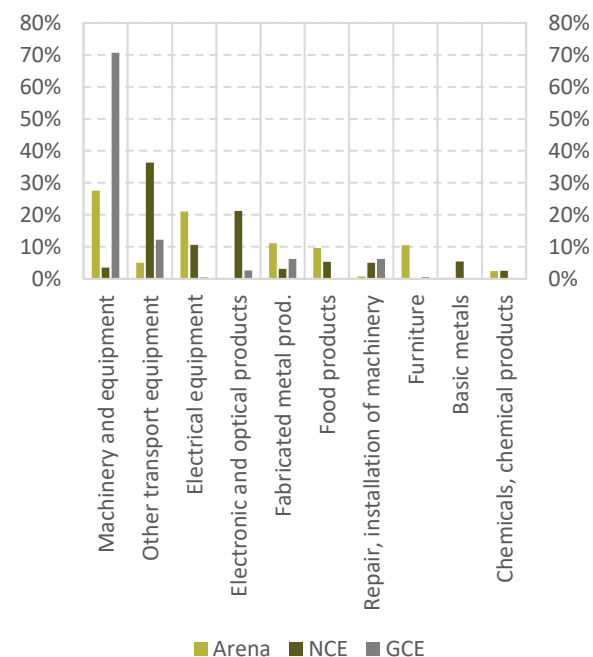
Each cluster project's objective(s) naturally affects the cluster's industrial composition. Some clusters gather firms within the same value chain and/or market, whereas others gather firms with common technology or need of competence.

Looking at which industries that make up the largest proportion of members in the different clusters, it is apparent that professional, scientific and technical activities and ICT is the largest industry in several clusters, regardless of objectives (cf. table 2.4).

Manufacturing represent, in relative terms, a significant share of employment across the three cluster levels, compared to the rest of the economy (cf. figure 2.6).

Figure 2.5

Number of employees among industries within manufacturing (two-digit NACE).¹ Share of total employment in manufacturing per cluster level. Total for 2003-2016



Source: Samfunnsøkonomisk analyse

1) Only top 10 industries within manufacturing included

Employment shares within selected manufacturing industries, such as manufacturing of machinery and equipment (NACE 28) and manufacturing of other transport equipment (NACE 30), shows a clear orientation towards the petroleum industry among the clusters (cf. figure 2.5). Further, support activities for petroleum and natural gas extraction (under mining and quarrying) represents more than three times the proportion of employees among core members of

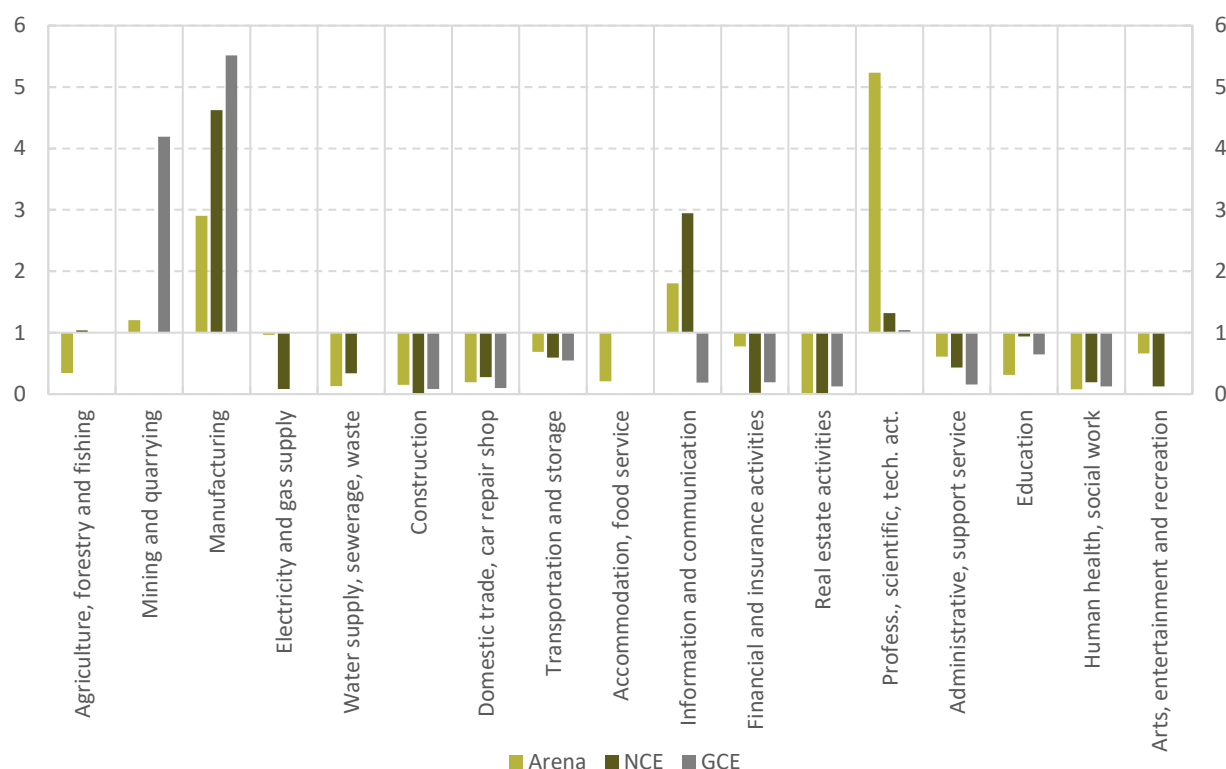
the three GCE clusters, than in the rest of the economy.

It also appears that Arena and NCE clusters have a relative advantage within ICT and professional, scientific and technical activities. The relative industrial advantage within ICT can be attributed to media-, energy- and health-oriented cluster projects.

The relative advantage within ICT has become clearer in recent years. Including only cluster projects established the last four years, ICT is by far the

Figure 2.6

Relative industrial advantages by cluster level.¹ Number of employees. Balassa index.² Total for 2003-2016



Source: Samfunnsøkonomisk analyse

- 1) All activities within mining and quarrying are related to "other support activities for petroleum and natural gas extraction"
- 2) The index is equal to each industry's proportion of the total number of employees among core members for the three cluster levels, divided by the industry's proportion of the total number of employees in all other firms in the sample (all existing LLCs in the given period not member of a cluster). An index greater than 1 indicates a stronger representation of the industry among the clusters compared to the rest of the economy and vice versa.

dominate industry (measured in relative employment shares). Further, there are almost no firms within mining and quarrying among these cluster project.

2.8.4 Overall economic development

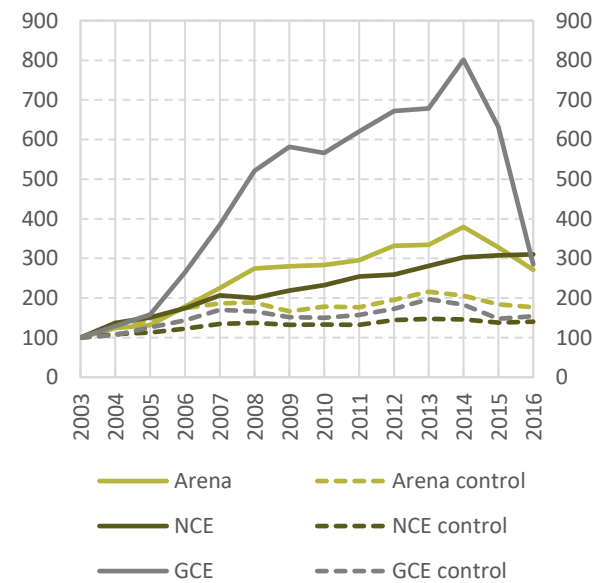
The clusters' industry composition will affect the overall economic development of the cluster. A first glance at growth in value added among core members, shows a positive trend throughout the period 2003-2014 at all cluster levels. For NCE members, in total, this positive trend continued, whereas falling oil prices seems have hit the overall growth among Arena and GCE members since 2014 (cf. figure 2.7).

Further, compared with other firms in the same industries, growth in value added has been higher among firms participating in a cluster project. We find the same pattern for the development in employment. However, this does not answer whether the higher growth is due to cluster participation or other characteristics of these firms. This will be explored in more detail in Chapter 6.

There is little difference in productivity between cluster participants and other firms.

Figure 2.7

Total value added. Core members and other firms.¹ Constant 2016-prices. Index (2003=100). 2003-2016



Source: Samfunnsøkonomisk analyse

1) Weighted sum for LLCs never registered as member of a cluster project (weighted by industry share per cluster level)

3 Economic relevance of clusters and cluster policy

Norway has a relatively wide portfolio of industrial policy schemes. Some schemes trace back to the 1960's, others are relative new. The importance of clusters in national and regional economic development has been acknowledged in several European countries since the 1990s and governments have designed cluster policies aiming at promoting clusters for more than two decades. Norwegian Innovation Clusters is a relative new scheme. However, Norway has had a strategy to strengthen industry clusters through national cluster programs since the beginning of the 2000s (see Chapter 2).

Industrial policies should facilitate the greatest possible value creation, within sustainable budgets. Thus, resources must be allocated to where they create the most value. Economic theory suggest that economic return and growth are maximised when markets are free and well-functioning. In well-functioning markets resources are allocated to where they create the most value (Smith 1776). However, economic theory also suggests that not all markets are well-functioning. Information asymmetries, natural monopolies, public goods or principal agent-problems are examples of so called markets failures. When markets fail to work properly it may be right or necessary to interfere. The industrial policies therefor seek to actively facilitate well-functioning markets by correcting market failures where appropriate (Meld. St. 27 (2016-2017)).²⁰

3.1 Cluster theory

Most economic activity take place in geographical clusters; in towns and cities, and in geographically confined business communities, as has been acknowledged since Alfred Marshall's seminal work

"Principles of Economics" (Marshall 1920). In his work, Marshall identified several benefits of clusters for firms' performance. However, the breakthrough resulting in how most view clusters today, came with Porter's *"The Competitive Advantage of Nations"* in 1990 (Porter 1990).

The cluster literature can be divided into three main fields; Michael Porter's theory on the competitiveness of countries and regions (e.g. Porter (1990) and (1996)), Paul Krugman and his co-theorists' work in the field between international trade, businesses' choices of location and geographic economic agglomeration (e.g. Krugman (1991a) and (1991b), Krugman and Venables (1995), Venables (1996)), and the field of national and regional innovation systems (e.g. Martin, Mayer and Mayneris (2011), and Asheim, Smith and Oughton (2011)), which may constitute a helpful supplement to our understanding of clusters and innovation. To better understand the rationale for Norwegian Innovation Clusters and how the scheme is supposed to lead to industry growth, we give a short description of each of these main theories below.

3.1.1 Porter's Diamond Model

Porter's origins are in business strategy, and his work on competitiveness at the macro level is built upon his knowledge of factors affecting companies at the micro level. In sum, his understanding of clusters is that companies that are co-located, benefit from a joint specialised labour market, lower transport costs, and a form of tacit industry knowledge. He defined a cluster as *"a group of industries connected by specialised buyer-supplier relationships or related by technologies or skills"*.

²⁰ Industrial policies can also be used to reach other objectives, i.e. protect national markets or players of strategic importance from international

competition. Such interventions are, however, limited by international agreements.

Results and insights from Porter's empirical studies laid the foundation for the term "Porter's Diamond". The framework in the diamond model can be summarised with four relations and their attributes:

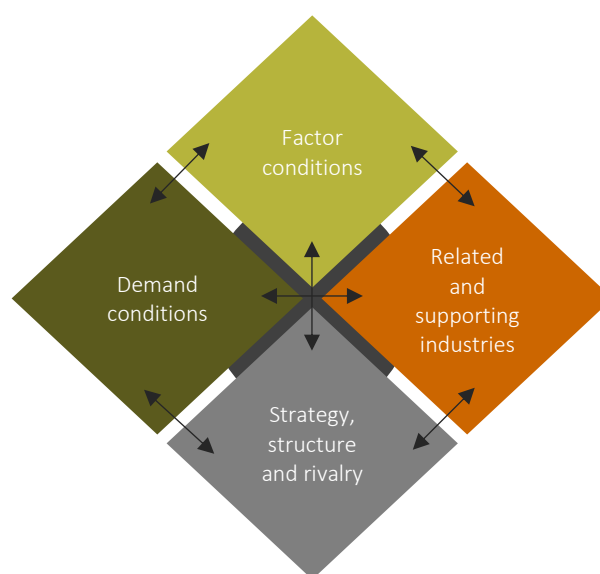
- *Factor conditions.* The cluster's position in factors of production, such as skilled labour or infrastructure necessary to compete in each industry.
- *Related and Supporting Industries.* The presence or absence of supplier industries and other related industries that are competitive is of critical importance for growth.
- *Demand Conditions.* The nature of demand for cluster's products or services is the primary source of growth, innovation and quality improvement.
- *Firm Strategy, Structure and Rivalry.* The conditions in the cluster governing how companies are created, organised, and managed, as well as the nature of rivalry.

The nature of these four relations can be influenced by values of the society, the government and the public opinion, as well as coincidences, which determine how well a business, an industry, or even a country, will develop.

Porter's theory emphasises how different characteristics of these four relations leads to the best possible outcome. Following Porter, business activity is more valuable when and where businesses reciprocally influence each other, that is, when and where there exist cluster mechanisms. However, it is of equal importance that the businesses operate in a competitive environment which encourage innovation and efficiency. Succeeding in such environ-

ments imply that the businesses give value to demanding customers and to competition in relevant markets, such as the markets for products, input factors and input goods.

Figure 3.1
Porter's Diamond



Source: Porter (1990)

Porter emphasises that *"the process of clustering, and the interchange among industries in the cluster, also works best when the industries involved are 'geographically concentrated'"* (Porter 1990, 157).

Porter's main argument is that the business behaviour in clusters are a product of localised learning processes²¹, and that the importance of clusters is that they represent the basis for an innovation based economy (Asheim and Isaksen 1996).

²¹ Localised learning processes are frequently held up as the foundations for continued geographical 'stickiness' of innovation activities.

Based on his empirical work, Porter states that (all) strong clusters are characterised by three central upgrade mechanisms:

- Innovation spillover
- Complementarity
- Knowledge spillover

Porter's theory of clusters and related theories, suggests that clusters may not simply reduce the cost of production but also the cost of exchange, by enhancing trading relationships; related local discoveries may simultaneously enhance the knowledge base of multiple local firms; specialized local institutions can play a crucial role in facilitating complementarities (Porter and Emmons (2003); Sölvell, Lindqvist and Ketels (2006)).

Further, Delgado, Porter and Stern (2012) emphasised the following important results of their research, which also has implications for cluster theory and cluster policies:

"We find that the cluster and related clusters surrounding a region-industry matters not only for the growth of existing industries but also for the creation of new industries in a region. In other words, new regional industries are born out of strong regional clusters. These findings suggest that clusters play a crucial role in the path of regional economic development (Porter 1990, 1998, 2003; Swann, 1992).

(...) First, the traditional distinction between industry specialization and regional diversity is misplaced. This dichotomy overlooks the powerful role played by complementary economic activity in shaping economic growth, and the central role of clusters as the manifestation of complementarity. Narrow regional specialization in an industry is likely to result in diminishing returns, and the presence of unre-

lated economic activity is unlikely to significantly enhance opportunities for growth but may increase congestion. However, the presence of complementary activity via clusters is a strong driver of growth through allowing firms ready access to key inputs, better interactions with customers, and facilitating experimentation and innovation." (Delgado, Porter and Stern 2012, 34).

Porter do not explicitly discuss the government's role in fostering clusters, but points out the importance that clusters facilitate both collaboration and rivalry between firms, as well as collaboration between firms and academia.

3.1.2 Krugman's Economic Geography

While Porter's theories stem from the field of business strategy, Krugman's contribution *"Increasing Returns and Economic Geography"* from 1991 signifies the start of the new economic geography and the economical-theoretical breakthrough in the understanding of business clusters (see Krugman (1991a)).

Krugman's theories regarding clusters are deeply rooted in general economic theory. He addresses problems from the field of geographical economics with microeconomic theory and theories of international trade. Compared with Porter, Krugman is somewhat narrower, in the sense that his formalised analyses demand stylised assumptions and a more constrained set of mechanisms. However, his approach yield results that are easier to interpret, are more in line with general economic insight, and easier to relate to policy making.

Krugman's theory draws on the positive knowledge-based externalities²² that exist within industry clusters, which means that co-localised firms learn from each other through knowledge spillover effects, both by way of the labour market and of the knowledge market. Lack of competition in specialised supplier markets, may also imply a market failure. More competing suppliers increase competition and reduce production costs. Greater geographical concentration of customers and suppliers can contribute to this.

Firms close to each other may also develop common infrastructure to reduce costs. Thus, significant gains can be achieved through co-location. Concentration of firms also means that competition is higher, ensuring an effective social resource allocation, and where possible, lower costs.

Krugman's main idea is that firms must be located close to each other to benefit from the externalities and overcome other market failures. By pointing out market failures Krugman's perspective has a clear industry policy implication; it is an advantage for a country to facilitate dynamic industrial clusters. However, exactly how this should be done must be developed by policy makers.

3.1.3 Regional Innovation Systems

The theory on Regional Innovation Systems (RIS) was developed in parallel with the literature described above. While Porter is more focused on the role of clusters in explaining competitive advantage at the regional or national level, and Krugman on the effect of static efficiencies on value creation in clusters, RIS emphasises the effect of networking, so-

cial and institutional interactions and learning processes on innovation in "learning economies" (Asheim, Smith and Oughton 2011).

It is important to notice the distinction between networks and clusters, for each promotes different types of external economies. In clusters, firms benefit from external economies such as knowledge spillovers or the attraction of labour and consumers to the cluster through market processes. In the case of networks, firms engage in cooperative activities, i.e. the external economies are realised through co-operation – not competition – and is internal to the network, if not the firms themselves (Asheim, Smith and Oughton 2011).

A key argument for the RIS approach is that the occurrence of technological change and innovation is determined by the interaction between private- and public-sector organisations, authorities, knowledge institutions and financial providers, combining creation, development and diffusion of technologies and innovations. It is important to understand that the system cannot be understood by focusing on the activities of any of its components in isolation (Asheim, Smith and Oughton 2011).

In modern innovation theory, learning is emphasised as a localised, and not a placeless process, and geographical proximity and territorial agglomeration is expected to greatly facilitate the needed learning processes (Storper and Scott 1995). Thus, the RIS theory acknowledges that clusters, as understood by Porter's and Krugman's theories, are important, but it also emphasises a range of other factors promoting and diffusing innovation within a region.

²² Examples on direct externalities can be the benefit or cost of an activity that affects a party who do not take part in the activity, e.g. education will

normally gain the individual who gets the education, but also anyone who gets access to better educated labour. The latter is an external effect.

Theories on *innovation and business ecosystems* also emphasise that local innovation collaboration is important in understanding how innovations occur. These theories focus on dynamic, purposive communities with strong relationships based on collaboration, trust and co-creation of value and sharing complementary technologies or competencies (Durst og Poutanen 2013). Innovation Ecosystems are usually created around a central node – technology platform, social or economic conditions – that put key agents together to interact. The Innovation Ecosystem idea has also been evolved towards several levels of organisation (Gooble 2004).

3.1.4 Links between the main theories

All abovementioned theoretical approaches suggest that clusters bring economic growth. However, the view on how clusters contribute to growth differs. In Porter's view, clusters are important to society because they contribute to competition and innovation, and thus increased exports, whereas Krugman sees export and innovation levels as almost irrelevant. What matters in Krugman's theory is whether the total value added to society is larger than what it would have been without clusters. In the theory of regional innovation systems, geographical clustering is important because it facilitates collaboration and learning processes necessary for innovation creation and diffusion.

While Porter emphasises the effect of competition on innovation, Krugman only emphasises competition to the degree that higher competition decreases production costs in the cluster, thereby facilitating growth and value creation. The RIS theory, as mentioned above, emphasise active collaboration and not competition.

All three theories however, stress the importance of geographical concentration, though to different degrees. Porter argues that competitive advantage is

both created and sustained through highly localised processes (Porter 1990), and that the process of clustering works best when the industries are geographically concentrated (Porter 1998). For Krugman, geographical concentration is to a large degree necessary for the exploitation of external economies, and thus highly emphasised. The RIS theory, on the other hand, emphasises geographical proximity to the degree that it is understood as an important facilitator for the innovation processes, also through how it enables the exploitation of external economies as in Krugman's world. In sum, Porter's view leans on dynamic efficiencies, revolving around the rate of learning and the capacity for innovation, which is very much in line with modern innovation theory, as represented by RIS. Krugman relies more heavily upon static efficiencies such as economies of scale.

RIS does, to a higher degree than the other two methodologies, emphasise collaboration not only between firms in a cluster, but also between different actors in a larger network of private and public R&D actors, knowledge centres et cetera.

3.2 Rational for publicly supported clusters

Though theory suggest that clusters bring economic gain, they are not alone a justification for public support of clusters. A prerequisite for public support is that these economic gains could not have been realised without the public support. That is, it presupposes the existence of a market failure that prevents economic growth to some degree. One such market failure could be the existence of external economies (positive externalities), which without internalisation (through public intervention), would not be exploited. Thus, the clusters will not be able to reach their full potential.

The following argument for public support of clusters, with focus on economics of scale, are mainly based on arguments creditable to Krugman and his co-theorists.

Most economic activity takes place in geographically confined clusters. Firms' choice of location normally reflects costs and market access. With equal access to relevant markets, they will prefer the location with the lowest production costs. Given equal costs, they will prefer the location with best access to relevant markets. The cost assessment implies locating close to natural resources, in areas where infrastructure is well developed, and/or the availability of essential inputs or intermediate goods is good. Market access implies locating close to customers, which in most cases means close to large population concentrations.

The existence of clusters is, however, not fully explained by conditions such as access to natural resource or a given distribution of population in cities and towns. Accumulation of business activity in clusters should rather be explained by the fact that there is some form of synergy gains between firms located close to each other, and where one firm's profitability is positively affected by the proximity to other firms.

Two factors can give rise to this kind of synergy gains:

Real externalities, i.e. direct, positive links between firms. Positive external effects mean that one firm, through its activity, imposes gains that do not fall as income to that firm. The classic example is when knowledge acquired in one firm, directly benefit the neighbouring firm.

Market links (so-called pecuniary externalities), i.e. positive effects that one firm imposes on others because its presence helps to create a larger market for end products, inputs, or key resources such as labour and capital. However, for market links to create synergies, there must be economies of scale somewhere in the value chain, so that the market size is restricting competition and/or product range.

In the presence of positive externalities, due to the abovementioned, a firm's private economic disposition will, without intervention, deviate from the best from a socio-economic point of view. That is, the firm will underestimate the value of its production and location. The existence of such external effects therefor gives a good reason for authorities to intervene in a market economy, to improve resource utilisation (Strøm and Vislie 2007).

How co-operative gains affect the marginal return of an input, and thus the size of the cluster, can be elaborated with an example: We assume an economy with two industries, one with a high degree of cluster characteristics (increasing returns to scale), and one without such characteristics (decreasing returns to scale). Further, firms in the two industries use only two inputs in their production; capital and labour.

Given a set of assumptions, there exist three possible equilibria in this example, A, B, and C (cf. figure 3.2). In A and B, the capital is divided between the two industries such that the marginal return on capital is equal in both industries. Point C represent an outcome where all capital is invested in the non-cluster industry. If the initial division of capital is somewhere to the left of point B, point C is a stable equilibrium, because the marginal return on investment in the non-cluster industry is always higher than the marginal return on investment in the cluster industry. Once point C is reached, no market agent

will have any incentive to move capital to the cluster industry.

Starting out in point B, the marginal return on investment is the same in both industries, but an infinitesimal investment in either group would shift the marginal returns in favour of that group, hence, point B is an unstable equilibrium.

Point A is a stable equilibrium. To see this, consider a situation where we start out with capital divided as in point A. If one were to move a small part of the capital from the non-cluster industry to the cluster industry, the marginal return on capital would subsequently be higher in the non-cluster industry, and the market agents would move the capital back to A, and vice versa.

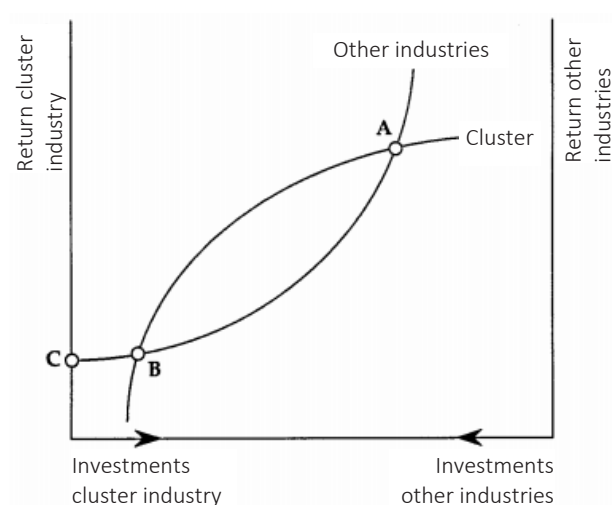
Points A and C represents the only stable outcomes of the model. In point C, as we've seen, no cluster firms will exist, and the total value creation is less than in A. Thus, A is the desired outcome.

However, whether the outcome will be point A or point C depends on exogenous factors. One such factor is what the market agents *believe* will be the outcome.

If no investors believe any other investors will invest in the cluster industry, or are even aware of the increasing returns to scale, there will be no investment, and the outcome will be point C. This matters a great deal, because it also implies that the government can affect the outcome, e.g. by applying funding schemes that incentivise the formation of clusters, thus leading the economy to the efficient outcome, point A.

The theoretical example presented here is an argument to facilitate the establishment of clusters (kick-start), e.g. through subsidising collaborative processes. Arguments for more long-term support for clusters, e.g. in the form of public cluster programs, requires more detailed argumentation, which we will present in the following.

Figure 3.2
Allocation of capital between the cluster industry and an industry without cluster characteristics



Source: NOU 1996: 17, 38

3.3 Clusters as a tool for enhancing innovation

OECD (2007) assessed 26 different national programs meant to promote growth of clusters in 14 countries and found a variety of approaches to strengthen existing and initiate new clusters. While most programs seemed to be based on common assumptions about the value to society of clusters, including the importance of connecting people and skills and knowledge at a regional or national level, the objectives of the programs ranged from national competitiveness and strategic high-technology sectors to small-scale groupings of co-located firms.

The European Cluster Observatory have very similar findings in their reviews, but also concludes that there in more recent years has been a shift towards

programs focusing on mature clusters, internationalisation and international competitiveness, to a larger degree than before (European Cluster Observatory 2015).

A notable trend among cluster programs in the OECD countries, is an increased emphasis on innovation as an objective, also in programs not necessarily rooted in science and technology policies. Many programs also have in common that they have transitioned from targeting SMEs to support national competitiveness clusters, through innovation and technology.

The enhanced acknowledgements of clusters as a tool for enhancing innovation, raises questions about why innovation should be supported indirectly through supporting clusters instead of supporting innovation directly.

One answer could be found in the intersection between innovation theory and theory for cluster development. The relations between geographical proximity and innovation has especially been studied in the field of economic geography (see Storper (2013) for a comprehensive discussion). The theory points out how important collaboration between firms and firms and research institutions are to develop new ideas and commercialisation. This view is also an important part of theories on regional innovation systems mentioned earlier. At the same time, economic geography theory emphasises the importance of proximity for lowering the costs of transmission of complex tacit knowledge between enterprises (Storper 2013). Such complex communication requires understanding and trust that historically have come from face-to-face contact.

Even though cluster programs do not draw exclusively on Krugman's (and his co-theorists) theories, it is our interpretation that insight from this kind of

theories and theories on regional innovation systems form the justification for the cluster program. The argument is that cluster support will provide more collaboration and that more collaboration is necessary to trigger more innovation.

This argument can be further elaborated to understand how public support can increase the extent of collaboration. It takes time for new collaboration patterns to expand and public (partly or fully) funded facilitators can help make this happen. The OECD assessment documents that this is how governmental programs do support clusters.

3.4 Cluster mechanisms

In the wake of the evaluations of Arena and NCE, Jakobsen and Røtnes (2011) discussed how public cluster support could be understood within a formalised framework. That is, to understand how public cluster programs may result in significantly larger benefits than collaboration which would have taken place without the help of such programs.

It is important to bear in mind that collaboration will take place even without public support, but public support should enhance the magnitude and direct the objectives of the collaboration activities.

Jakobsen and Røtnes developed a conceptual model for cluster-based development to illustrate typical cluster characteristics and how they lead to improved performance (see figure 3.3). The solid lines in the figure illustrate direct effects, whereas the dashed lines illustrate long-term effects generated by system dynamics.

Capability and willingness to initiate and carry out collaboration processes to realise potential synergies depend on the groups' relational basis for collaboration. If potential synergies are significant and

the relational basis is in place, actual collaboration processes will result in gains such as innovation, improved productivity and/or internationalisation, and consequently growth and profitability (illustrated by the solid lines in the model).

The model can be interpreted as a situation where the yield curve for cluster industries is lifted upwards (cf. figure 3.4). Such a situation generates a new equilibrium (D) where the cluster industry expands at the expense of other industries. In such a situation, in principle, the productivity (return on resources) will be higher in all industries, compared to the initial situation.

Potential synergies between the actors in the group – or potential external economies of scale – exist if there are:

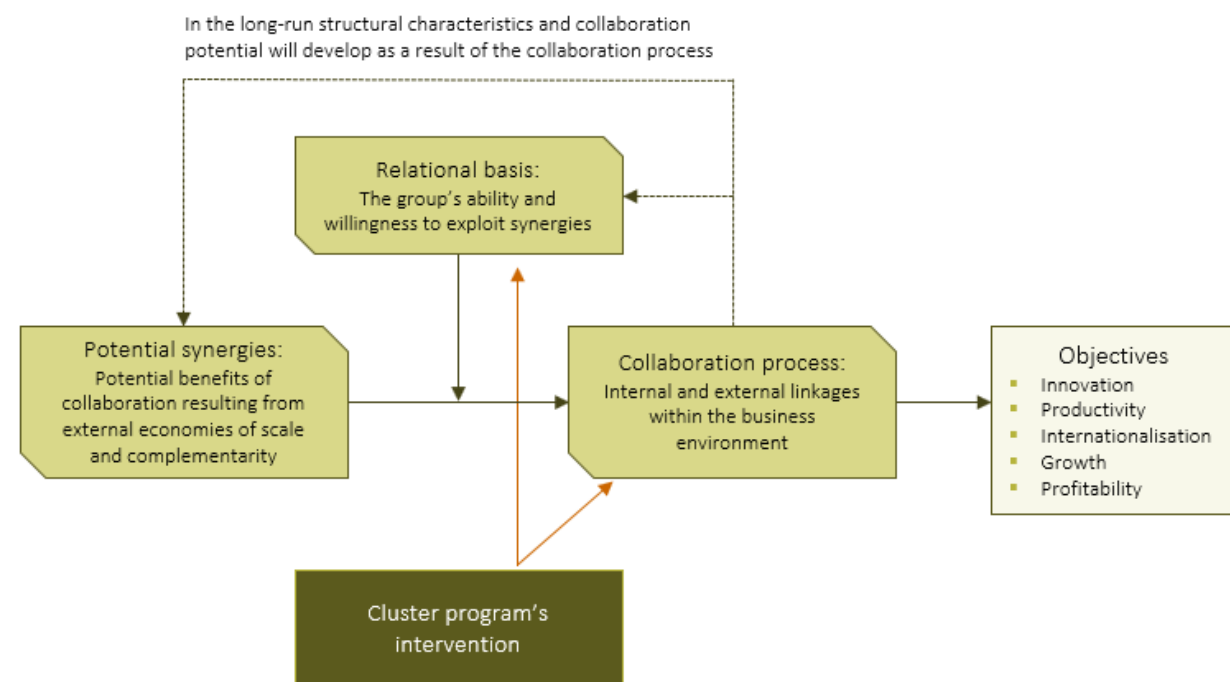
- *Economies of scale* in activities that are *collective for the actors and non-excludable*
- *Complementarity* in markets and/or competences, activities and resources

Potential synergies between actors in a cluster can be realised through *collaboration processes*, i.e. through internal and external linkages within the cluster:

- *Collaboration and sharing of resources within the cluster*: Formal and informal collaboration where the actors *develop* (innovation), *share* (economies of scale) and *transfer* (complementarity) resources between each other
- *External linkages to business environments*: The actors within the cluster's connections to related national and international industrial milieus, including their own subsidiaries/offices within these milieus

Figure 3.3

Conceptual model for cluster-based development

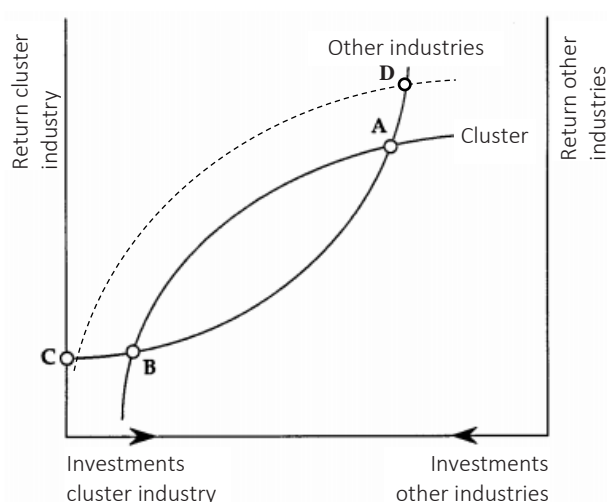


Source: Jakobsen and Røtnes (2011)

- *Linkages to knowledge institutions:* The *number* and *competence level* of relevant actors within education and research and specialised suppliers of knowledge in the region, as well as the *extent and strength of the links*
- *Links to professional capital providers:* The extent of owners/investor groups in geographic proximity and/or are specialised towards a certain cluster's market, technology and competence

Figure 3.4

Allocation of capital between the cluster industry and an industry without cluster characteristics ^{w/}new equilibrium



Sources: NOU 1996: 17 and Samfunnsøkonomisk analyse

Even though potential synergies between the actors within a cluster clearly exist, they might still not be realised. Actors might lack sufficient information about other actors' activities to know when collaboration might result in mutual benefits.

The incentives to invest in collaborative relationships might also be unevenly distributed. Trust is in many cases the decisive factor to make collaboration work in practice, and if there is a lack of trust, collaboration may seem like too much of a risk. In other words, the actors' ability to realise potential

synergies through collaboration processes depends on their relational basis for collaboration, i.e. whether they trust each other enough to be willing to share their knowledge and invest in the community.

3.5 Cluster programs' role

It is important to distinguish between cluster effects, i.e. effects resulting from collaboration in clusters, and effects of the cluster program. The cluster programs' role is to stimulate cluster development, or more specifically to *trigger collaboration-based development* which otherwise would not have happened, and to *reinforce and accelerate existing collaboration*. This is both about stimulating collaborative potential (relational basis) and about financing and enabling specific collaboration processes.

In the conceptual model above, the cluster programs' role is illustrated by orange lines. That is, the cluster programs' activities aim to

- Strengthen clusters' relational basis for collaboration
- Finance, organise and carry out specific collaboration projects

Norwegian Innovation Clusters aims to promote and enhance collaboration activities in clusters, which is an important reference to policy implication from theories based on economic geography and of regional innovation systems.

"The services offered to the clusters comprise financial and professional support to help them initiate, strengthen and accelerate various collaboration processes. The support acts as a catalyst for developing new collaboration relations and concrete collaboration measures to strengthen joint knowledge

development, innovation processes, internationalisation measures etc. Public involvement also serves as a neutral and 'safe' framework for the collaboration in that it reduces the risk of any party reaping unreasonable benefits.” (Innovation Norway 2015).

Based on review of program descriptions and instructions it is our assessment that policy makers have good reasons to expect cluster support to affect clusters in two ways. First, cluster policies could increase the size of existing clusters (by allocating resources to these firms), and thus improve the performance of firms by reaching a critical mass, which allows the firms to exploit the theoretical external economies. Second, for a given size, cluster policies could enhance and improve the collaboration activities within the cluster.

Norwegian Innovation Cluster appears as a relevant program to enhance innovation, and subsequently increased value added, that would otherwise not have happened. Although there are reasons to expect positive effects on collaboration, innovation and value added, these possible effects must be identified in accounting data to conclude whether the program reach its objectives. This will be discussed in the following chapters

4 Significant interaction with other schemes

The cluster program offers services and tools that act as catalysts for enhanced collaboration on strategic needs within each cluster project. It will not solve all challenges but is supposed to be utilised in close interaction with R&D, innovation and infrastructure schemes, so that they in sum can contribute to powerful efforts towards environments with potential for value creation (Innovation Norway 2015).

To distinguish between the effect of the cluster program and other schemes intended to have impact on individual firm performance, we need to know the extent of support from other (relevant) public funding schemes.

In addition, the extent of other schemes channelled to the cluster participants can be seen as a result of the cluster program itself. There may be two reasons for this; Firstly, several cluster facilitators assist firms in providing information about the possibilities of using public schemes to support various innovation projects. Secondly, given that participating firms to some extent have revealed their innovation potential by being included in the cluster program, participation can increase the likelihood of being approved for support from other schemes.

In the following we document the cluster participants' support from other public schemes.²³ Our data does not allow us to determine the causal link between changes in the use of other schemes and cluster participation. The analysis below should therefore be read as a clarification that cluster participants makes themselves both more qualified for

other schemes and increase their visibility among relevant funding agencies.

4.1 Relative importance of other schemes

Of the 1 068 core members in our sample, 793 (74.3 pct.) firms have received support from one or more public schemes (apart from participation in a cluster project).²⁴ The share of firms with support from other schemes is somewhat higher among members of a NCE or GCE cluster, than Arena. In addition, there are differences in the types of schemes that constitute the largest share of the various members' total support.

Norwegian Innovation Clusters gather several of Norway's most export-oriented firms. Most firms, regardless of cluster affiliation, export goods and services without the need for public export financing. It is still worth noting that cluster's core members have received about 60 pct. of all loans and guarantees given by Export Credit Norway and the Norwegian Export Credit Guarantee Agency (Giek). By comparison, the same firms account for 16 pct. of all limited liabilities that have received loans and guarantees from these agencies. Further, almost all loans and guarantees have accrued to a few participants in the three GCE clusters.

Comparing different funding agencies' share of the total number of core members utilising different schemes with their share among other supported firms²⁵, it is apparent that Export Credit and Giek constitute a significantly higher share among the cluster participants than others (cf. figure 4.1).

²³ 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 from 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.

²⁴ Schemes funding agriculture activities and energy efficiency measures are excluded. If such funding is included, 850 of the core members have received support from one or more public schemes.

²⁵ Limited liability companies

In addition to being “overrepresented” among export-oriented schemes, funding agencies providing equity investments, such as Argentum and Investinor, constitute a relatively high share among the core members. The same holds for most R&D-oriented schemes (EU’s Seventh Framework Programme (EU FP7) and Horizon 2020, The Norwegian Seafood Research Fund (FHF) and Regional Research Funds).

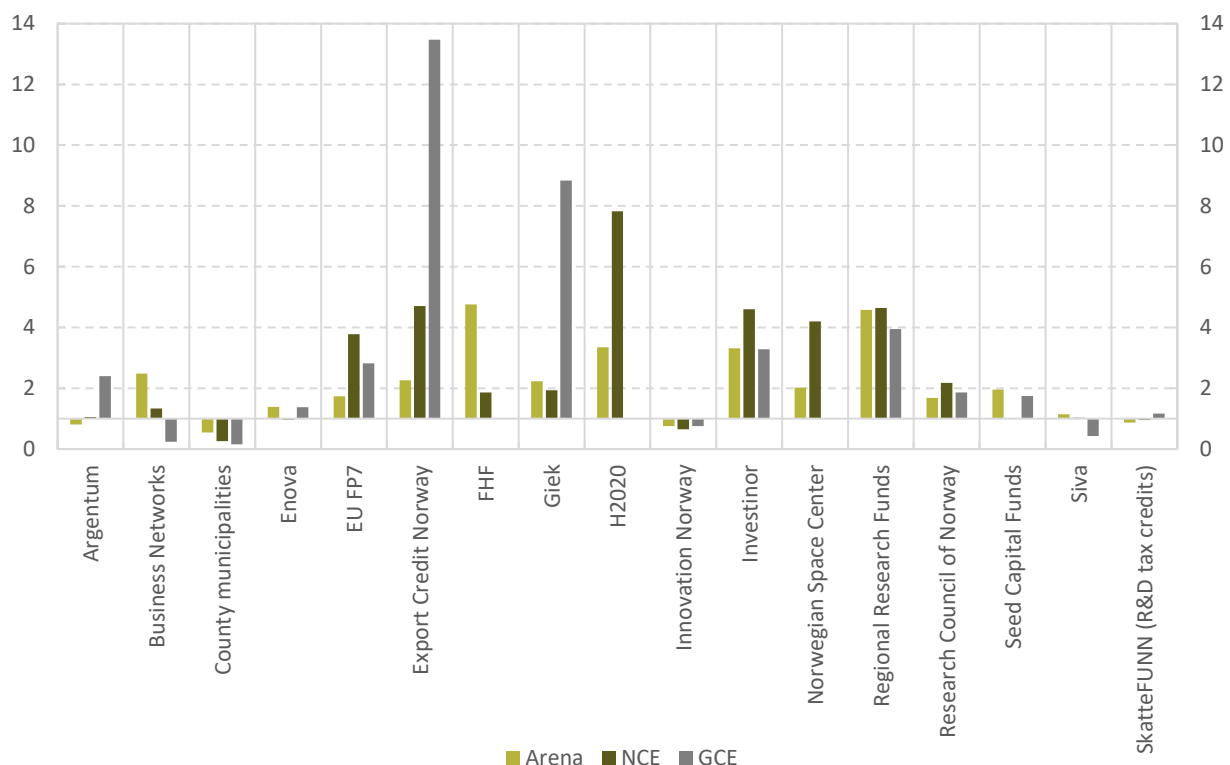
It is apparent that different funding agencies’ relative importance for the cluster participants differs among cluster levels. What kind of schemes the participants make use of must also be seen in light

of the clusters projects’ composition of firms. Further, it may also be explained by the schemes’ design or formal requirements, e.g. requiring collaboration between firms and R&D institutions. In such cases, cluster participants may have an advantage by exploiting the already established network within the cluster.

The three owners of the cluster program (Innovation Norway, the Research Council and Siva) are all important sources of funding for the cluster participants, but, except for the Research Council, not more than they are for limited liabilities in general.

Figure 4.1

Relative importance of funding agencies by cluster level. Funding agencies’ relative share.¹ Total² for 2000-2016

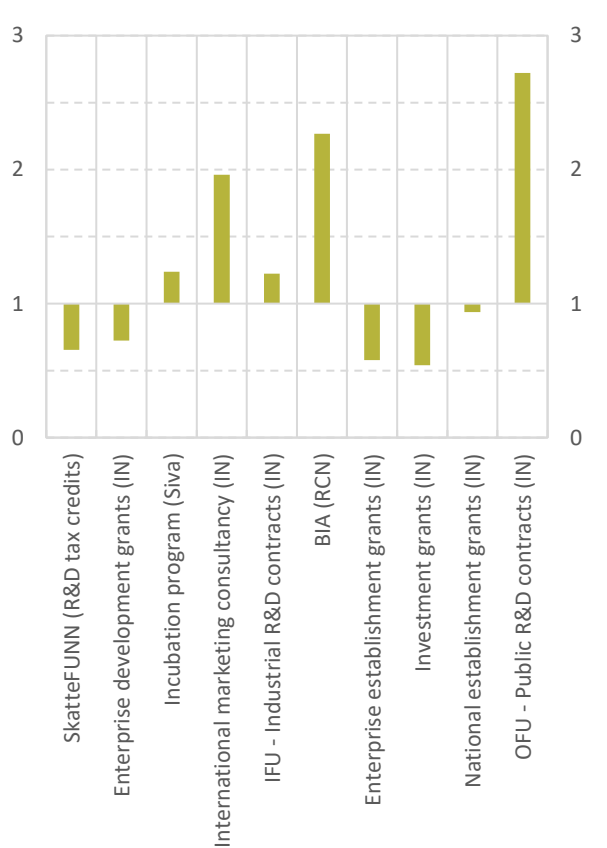


Source: Samfunnsøkonomisk analyse

- 1) Relative share per agency indicates the relationship between the agency’s share of firms in the sample (core members at each cluster level) and the agency’s share of all other LLCs with support from the respective agency. A factor greater than 1 indicates that the agency is “overrepresented” among cluster members and vice versa.
- 2) Sample only include core members and other LLCs (excl. research institutes organised as LLCs). Schemes funding agriculture activities and energy efficiency measures are excluded

Innovation Norway has supported a little more than half of all the core members, at all cluster levels, but do not represent a greater proportion among these firms than among other recipients of support from Innovation Norway.²⁶ Neither do Siva.

Figure 4.2
Top 10 public schemes for core members of Arena projects (ranked by no. of firms from left to right). The schemes' relative share.^{1,2} Total for 2000-2016³

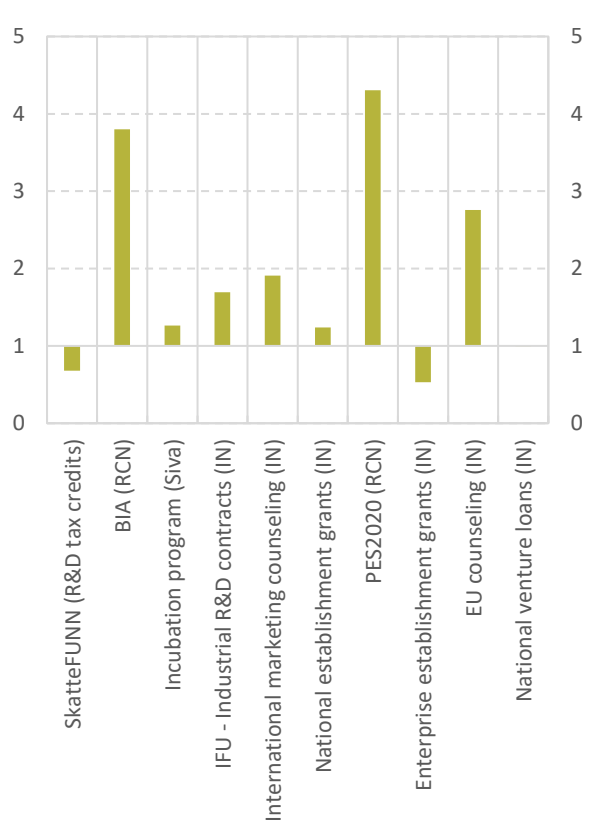


Source: Samfunnsøkonomisk analyse
 1) See explanation of the relative share in figure 4.1
 2) BIA - User-driven Research based Innovation
 3) The period varies for the different schemes, but they have been available to all in the period they have existed

The share of core members receiving funding for R&D projects from the Research Council varies between the three cluster levels, from almost one third

of members of an Arena or GCE cluster to just under half of the members of a NCE cluster. Overall, the Research Council is overrepresented among cluster participants at all levels.

Figure 4.3
Top 10 public schemes for core members of NCE projects (ranked by no. of firms from left to right). The schemes' relative share.^{1,2} Total for 2000-2016³



Source: Samfunnsøkonomisk analyse
 1) See explanation of the relative share in figure 4.1
 2) PES2020 - Project Establishment Support for H2020
 3) The period varies for the different schemes, but they have been available to all in the period they have existed

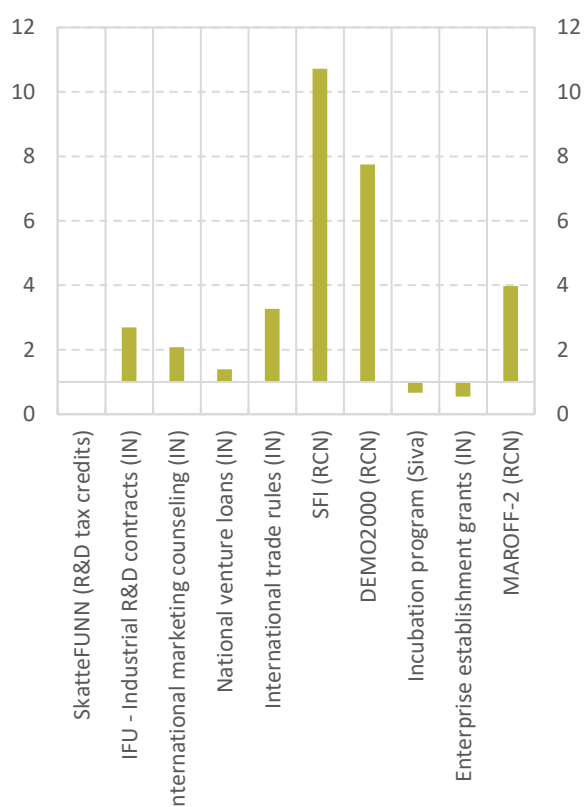
Measured in number of core members receiving support from different schemes, SkatteFUNN is the most used, independent of cluster level (cf. figure 4.2-figure 4.4). However, it seems to be relatively

²⁶ Support from the cluster program (see paragraph 2.5.2) is not included.

less important for participants of an Arena or NCE cluster than for others (relative factor less than one).

Figure 4.4

Top 10 public schemes for core members of GCE projects (ranked by no. of firms from left to right). The schemes' relative share.^{1,2} Total for 2000-2016³



Source: Samfunnsøkonomisk analyse

1) See explanation of the relative share in figure 4.1

2) SFI - Centres for Research-based Innovation, DEMO2000 - Project-oriented technology development in the petroleum sector, MAROFF - Maritime activities and offshore operations

3) The period varies for the different schemes, but they have been available to all in the period they have existed

SkatteFUNN is a rights-based R&D tax incentive scheme, intended to stimulate R&D in Norwegian trade and industry. Firms within all industries can

apply, regardless of firm size.²⁷ Eligible applicants are firms with R&D projects intended to develop a new or improved product, service or production process. The project must generate new knowledge, skill and capabilities within the firm.²⁸ Given the nature of the scheme, it is as expected that this constitutes the largest share of the firm's use of public schemes.

The main difference between the cluster levels appears to be increasing importance of the Research Council's different programmes (measured in number of core member being supported) with increasing cluster level. The shift in which programs and schemes are being used is probably also associated with the composition of the clusters, not only the cluster level. That is, there may be as big differences between clusters at the same level as across levels.

4.2 Changes in interaction with other schemes

There is reason to believe that cluster participation contributes to changes in the participants' use of public support schemes, both scope and type of schemes. At least if the facilitator makes participants aware of schemes they did not know, certain schemes require formalised collaboration and/or cluster participation signals the firm's potential for innovation or value creation.

Interviews conducted as part of this evaluation indicate that assisting members with applying for funds is something the facilitators devote resources to. Further, if we compare the core members' use of public schemes before and after enrolment in a cluster project, our data indicate that there has been

²⁷ There is however a distinction between SMEs and large firms when determining the tax credit (SMEs may be granted a tax deduction of pct. of the R&D costs associated with a given R&D project. Large enterprises may be granted a deduction of 18 pct. of such project costs).

²⁸ Read more about SkatteFUNN here: https://www.skattefunn.no/prognett-skattefunn/Home_page/1222340152176

an increase in the number of firms receiving some form of support after enrolment.

However, 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 enrolled in a cluster project around 2006 (most participants of a NCE or GCE cluster), the period of data is longer after enrolment 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.

Despite the above challenges, it is our impression that cluster projects appear to be particularly relevant for firms with a R&D potential, though they are in no way restricted to it. Cluster projects may also (and should) encourage R&D through joint projects. This is discussed in more detail in the next chapter.

5 Significant effects on collaborative relationships

Norwegian Innovation Clusters, as well as similar cluster programs internationally, has a clear objective to enhance collaboration activities. Our interviews with members of the seven cluster projects subject for evaluation (see list in Chapter 1) confirm that this is a prioritised task.²⁹ In this chapter we analyse whether it is possible to confirm such results in data on cluster members' formalised research collaboration.

Immediate effects resulting from enhanced visibility and identity necessarily diminishes with time. Maintenance of collaborations depends on initiated activities and processes being perceived as relevant for the participant, also in the long run. Thus, it is of interest to assess whether the cluster program affects the number of collaborative relationships.

The success of collaboration projects in form of innovations and patents is often assumed to be dependent on knowledge transfers among the different participants. Such knowledge spillovers can be either direct between two contributors working in the same project or indirect, i.e. when knowledge circulates between contributors to different projects if there is a mechanism for flow of information such as a mutual third contributor to both projects.

There have been several collaboration projects between and within different cluster projects in recent years. To answer how this kind of relationships and projects arise, how they work and what results and effects they create we exploit Innovation Norway's own survey to cluster participants, conducted interviews and our own on database in public support.³⁰ The latter allows us to map formalised R&D collaborations in projects with public funding.

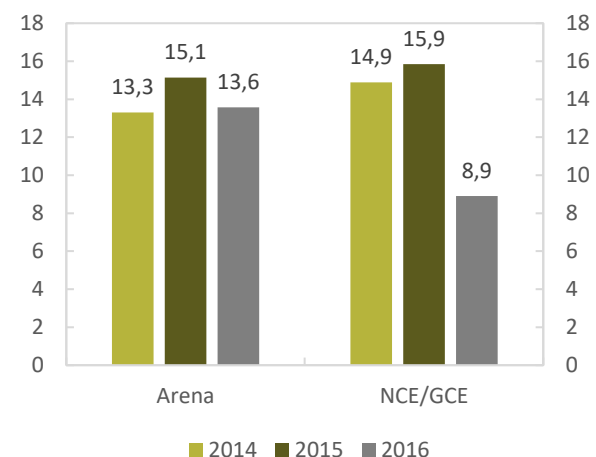
5.1 Reported collaborative relationships

Innovation Norway has, as part of their system for Management by Objectives and Results (MBR), developed a small-scale survey targeting the members of the different cluster projects. The purpose of the survey is to map the number of firms that have established new or enhanced existing collaborative relationships. It has been conducted the last three years.

Respondents in the 2016-survey reported on average 11 new collaborative relationships, as a result of cluster participation, with other firms or knowledge institutions.

Figure 5.1

Average number of new collaborative relationships by cluster level. 2014-2016



Source: Innovation Norway

On average it appears that the number of new collaborative relationships is relatively stable for members of an Arena project, whereas the last survey indicates a drop in the number of new relationships among participants of a NCE or GCE project in 2016

²⁹ The results from interviews and review of other project results is presented in own project reports.

³⁰ The database is described in note 23

(cf. figure 5.1). The latter may be a consequence of the downturn in the petroleum industry, which hit members of the GCE projects relatively hard (Innovation Norway 2016).³¹

5.2 Growth in formalised R&D collaboration

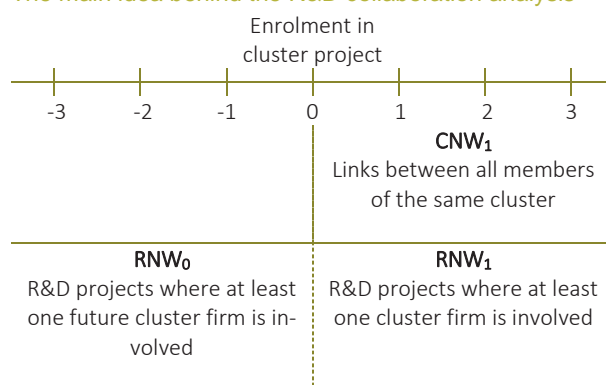
One of the objectives of the cluster program is to promote and enhance collaboration activities between firms and R&D and other knowledge institutions. Relating to the literature on network analysis and knowledge transfer in networks,³² we have checked whether participation in a cluster project has had an impact on the firms' R&D collaboration networks. To our knowledge, no one has used a network approach for R&D collaboration, perhaps because detailed information regarding the identity of project participants is typically hard to obtain.

Our data comprise detailed information on firms and research institutions that are engaged in different R&D projects (supported by the Norwegian R&D tax credit scheme SkatteFUNN, EU programs FP7 and H2020 and/or the Research Council of Norway). This information allows us to construct an R&D collaboration network for each cluster member counting direct links between them and other participants (collaborators) in the R&D project (primary network) and indirect links between cluster members and collaborator of collaborators (secondary network). We have also constructed cluster networks, i.e. links between all firms and research institutions participating in the given cluster.³³

As a result, we can form an overall picture of R&D relationships for cluster members, as well as changes in their collaboration network over time.

The main idea of our analysis is to check whether the size of the primary R&D collaboration network has changed after a firm has enrolled in a cluster project (illustrated in figure 5.2). As for the secondary network, we have constructed a set of potential R&D collaborators in the future by counting partners of partners in the present.

Figure 5.2
The main idea behind the R&D collaboration analysis



It is worth to note that this approach does not *fully* answer to what extent the cluster program has changed the degree of collaboration (we cannot observe informal collaboration and collaboration in projects without public support), but it gives an indication of the direction of changes resulting from the program. Further, if we do observe changes in formal R&D collaboration, it is reason to believe that there have been some changes in informal collaboration as well.³⁴

³¹ See paragraph 2.8.4 for economic development for these firms.

³² The social network approach (SNA) is an important empirical and conceptual contribution in the field of interorganisational cooperation. The picture provided by the network approach contrasts with other models that regard cooperation as a mere contractual and legal inter-corporate connection. While accepting the existence of formal types of collaborative arrangements, the network approach emphasises the importance of informal and emergent cooperation. Per today SNA has been used to investigate phenomena in many different fields like airline networks (Amaral, et al.

2000), industrial networks (Brito 2001), marketing analysis (Iacobucci and Hopkins 1992) and open source software projects analysis (Fershtman and Gandal 2011).

³³ In this analysis we include all firms that are members of the clusters (as is in the provided lists of members) not only those we defined as core members.

³⁴ Receiving funding from one of the R&D schemes requires some amount of effort, and in many cases probably more than in informal collaboration between two firms.

First, we fix the timing for each firm's enrolment year to zero. Then we construct a cluster network (CNW), i.e. the links between all firms and research institutions participating in the given cluster project during three years after a given firm has enrolled in the cluster project. All Arena cluster projects are included in the analysis, whereas only NCE cluster projects that primary started out as NCE (and not as a successor of an Arena cluster project) are included.³⁵ That gives us 57,514 unique links for Arena and 31,159 unique links for NCE in the period 2005-2015.

Second, we identify all R&D projects (in our database) that have at least one cluster member involved either as a project leader or as a collaborator. Based on this information we construct the firm's primary R&D network in the three-year period

prior to cluster participation (RNW_0) and in the three-year period after enrolment (RNW_1) by mapping all collaborators of the ongoing projects in these two periods.³⁶

Third, we study how the R&D collaboration network has changed, i.e. changes in the total number of links three years prior to enrolment (period 0) and three years after enrolment (period 1).

We observe more R&D projects with higher collaboration intensity (i.e. number of collaborators per ongoing project) in the three-year period after enrolment for R&D networks connected to members of both Arena and NCE projects (cf. table 5.1). Further, we observe an increase in the number of patent applications in total and among members of a cluster project.

Table 5.1

Cluster members¹ R&D collaborative projects² three years before and after enrolment in a cluster project

	Arena		NCE ³	
	3 years before t=0	3 years after t=0	3 years before t=0	3 years after t=0
No. of R&D projects				
Total firms in cluster network	1 543	2 436	702	1 332
No. with collaboration	963	1 512	240	633
Share with collaboration	62 %	62 %	34 %	48 %
No. of collaborators				
Average	15	17	18	19
Min	2	2	2	2
Median	13	15	17	16
Max	34	45	34	45
No. of patent applications				
Total by all collaborators	1 119	1 085	555	762
No. among cluster members	102	156	86	130
Share among cluster members	9 %	14 %	15 %	17 %
Patent application per project	0.73	0.45	0.79	0.57

Source: Samfunnsøkonomisk analyse

1) Excluded research institutes

2) Based on R&D projects with funding from the Research Council of Norway, EU FP7, H2020 and/or SkatteFUNN

3) Includes two GCE projects that started as NCE

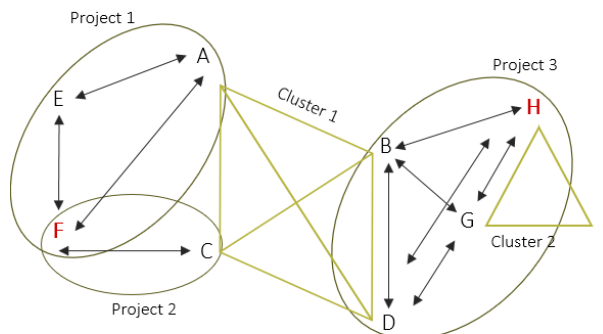
³⁵ These clusters are NCE Agriculture, NCE Instrumentation, NCE Micro- and Nanotechnology, NCE Oslo Cancer Cluster, NCE Raufoss, NCE Seafood Innovation Cluster and NCE Systems Engineering. This group of NCE firms also includes member of two GCE clusters that started out as NCE clusters (i.e. GCE Blue Maritime and GCE Subsea).

³⁶ Our data are available till 2016. Thus, to have at least one full year of cluster participation we restrict this analysis to the firms that enrolled in a cluster project no later than 2015.

However, we cannot claim that the observed increase is a result of cluster participation. Moreover, the number of patent applications per ongoing project is falling from period 0 to period 1, implying that number of projects has increased more rapidly than number of patent applications. One reasonable explanation is that it takes time before the project ideas are realised in the form of a patent application. Hence, it is even harder to claim that observed patent applications are connected to the ongoing projects in the given R&D network and not to other projects that took place earlier and/or outside the network. Given these observations we will restrict the further analysis to collaboration dynamics and intensity.

Figure 5.3

An example with two clusters and three connected collaborative R&D projects (in ovals)



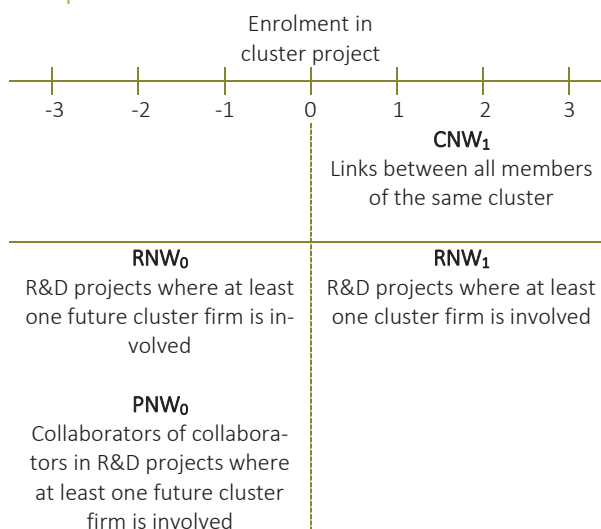
In the analysis, we distinguish between the following types of links between the participants in the identified R&D networks:

- Two firms in the same cluster (e.g. B and D in figure 5.3)
- A firm and a R&D institution in the same cluster (e.g. G and H in figure 5.3)
- Two R&D institutions in the same cluster (not represented by figure 5.3)
- Two firms in different clusters (e.g. D and G in figure 5.3)

- A cluster firm and an actor outside the cluster (e.g. A and E or C and F in figure 5.3)
- Two actors outside the cluster (e.g. E and F in figure 5.3).

Figure 5.4

Potential R&D collaboration through secondary R&D network prior to enrolment



It is worth to note that new partnerships (collaboration) in period 1 could be a result of realisation of potential R&D collaboration from period 0 (someone gets in contact with a new collaborator through their earlier common collaborator). For example, if firm A and firm C start a new project, we cannot tell whether this project is a result of their participation in the same cluster or of their earlier collaboration with R&D institution F.

To check which of the new collaborations in period 1 that are most likely established through a cluster network, and not through contacts with collaborators of collaborators, we also report the adjusted results by excluding the links observed earlier in the secondary network (cf. network PNW₀ in figure 5.4).

We observe an almost doubling of links in the three-year period after enrolment, compared to the three-

year period prior to enrolment, i.e. comparing RNW_0 and RNW_1 (cf. figure 5.5). That is, our results imply a significant increase in R&D collaboration after enrolment in a cluster project, for both Arena and NCE projects. This conclusion holds even when possible collaboration through secondary R&D network in period 0 is accounted for.

In period 0 we distinguish between links that were active only in period 0 (the corresponding R&D projects are finished prior to enrolment), and links that were observed in both periods (the corresponding R&D projects were active in period 0 and continued in period 1). In period 1 we distinguish between new links by the type of collaborators defined in the list above. It is apparent that collaboration between a cluster member and a firm/research institution that

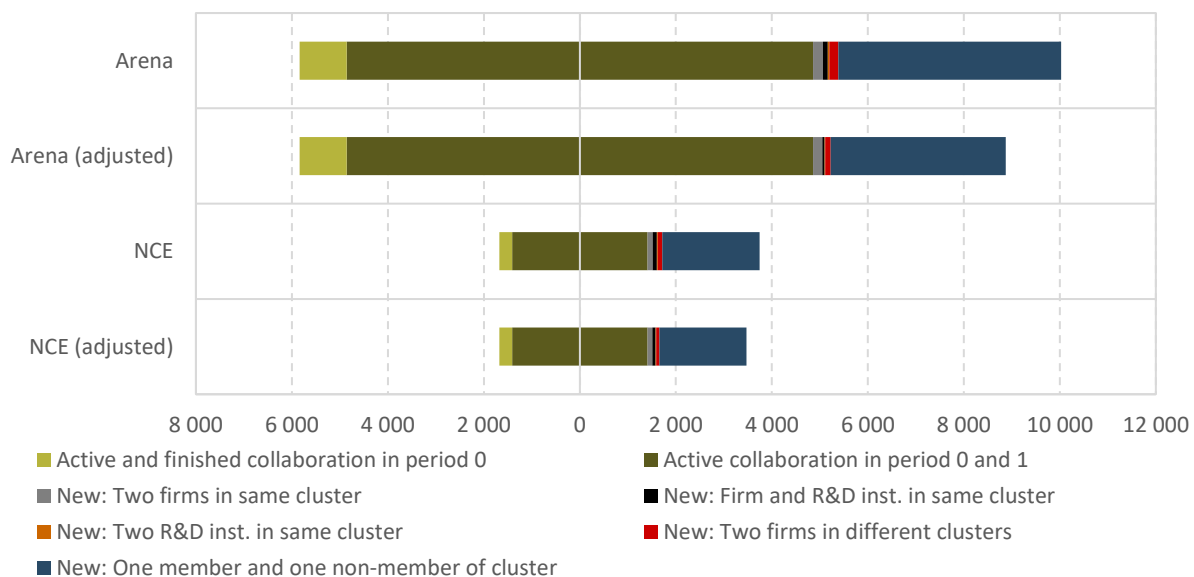
is not a part of any cluster project is the most common form of collaboration when looking at the new relationships.

However, after dividing links in period 0 by the type of collaborators defined in the list above, we observe the highest growth in number of collaborations between two members of the same cluster (cf. table 5.2 and table 5.3). Number of links for this type of collaboration is more than doubled after enrolment in a cluster project even after adjusting for possible collaboration through the secondary R&D collaboration network PNW_0 .

This result clearly indicate that Norwegian Innovation Clusters have achieved one of its objectives, i.e. to “(...) *trigger and strengthen collaboration based development activities within the cluster*”.

Figure 5.5

R&D collaboration before and after enrolment in a cluster project. Number of links



Source: Samfunnsøkonomisk analyse

Note: The year of enrolment is set to zero. The adjusted numbers are corrected for possible collaboration through the secondary network in the three-year period prior to enrolment in the cluster project (i.e. excl. links established with partners of partners)

Table 5.2

R&D collaboration before and after enrolment in a cluster project. Growth in number of links by type of collaboration. Arena projects

Collaboration	Types of links in R&D collaborative network ¹					
	Two firms in same cluster	Firm and R&D inst. in same Cluster	Two R&D inst. in same cluster	Two firms in different clusters	One member and one non-member	Two non-members
Active and finished in period 0 (RNW ₀ only)	12	6	4	19	940	3 297
Active in both period 0 and 1 (RNW ₀ and RNW ₁)	161	133	66	205	4 295	12 339
New in period 1 (RNW ₁ only)	204	99	37	185	4 640	13 697
Increase	192	93	33	166	3 700	10 400
Growth rate	111 %	67 %	47 %	74 %	71 %	67 %
Collaborators in RNW ₁ observed in PNW ₀ ²	16	46	27	69	991	2 167
Net increase ³	176	47	6	97	2 709	8 233
Net growth rate ³	102 %	34 %	9 %	43 %	52 %	53 %

Source: Samfunnsøkonomisk analyse

1) Based on R&D projects with at least one cluster member involved

2) PNW₀ is a network of firms who have a common collaborator in period 0 and are thus potential collaborators in period 1

3) Adjusted for potential collaborators from period 0 (PNW₀)

Table 5.3

R&D collaboration before and after enrolment in a cluster project. Growth in number of links by type of collaboration. NCE and GCE projects

Collaboration	Types of links in R&D collaborative network ¹					
	Two firms in same cluster	Firm and R&D inst. in same Cluster	Two R&D inst. in same cluster	Two firms in different clusters	One member and one non-member	Two non-members
Active and finished in period 0 (RNW ₀ only)	1	6	5	4	255	895
Active in both period 0 and 1 (RNW ₀ and RNW ₁)	64	67	42	44	1 191	5 185
New in period 1 (RNW ₁ only)	107	85	25	90	2 032	8 307
Increase	106	79	20	86	1 777	7 412
Growth rate	163 %	108 %	43 %	179 %	123 %	122 %
Collaborators in RNW ₁ observed in PNW ₀ ²	8	16	13	22	220	489
Net increase ³	98	63	7	64	1 557	6 923
Net growth rate ³	151 %	86 %	15 %	133 %	108 %	114 %

Source: Samfunnsøkonomisk analyse

1) Based on R&D projects with at least one cluster member involved

2) PNW₀ is a network of firms who have a common collaborator in period 0 and are thus potential collaborators in period 1

3) Adjusted for potential collaborators from period 0 (PNW₀)

As for collaboration between a firm and a research institution in the same cluster, it has increased by 67 pct. for members of an Arena project and 108 pct. for members of a NCE project (the corresponding rates after adjustment are 34 pct. for Arena and 86 pct. for NCE, which are lower but still imply an increase in collaboration).

Further, we find a high growth rate for collaboration between two firms in different clusters, especially for members of NCE projects. A possible explanation may be that these firms have more informal collaboration and contact than only through membership in the corresponding cluster. In addition, there is an expectation of cluster-to-cluster collaboration for NCE and GCE projects (cf. list of strategic priorities in paragraph 2.5.1).

The lowest growth rate is observed for collaboration between two research institutions in the same cluster. It is positive, but almost negligible when adjusting for potential collaborators from period 0. The

growth rate for this type of collaboration in Arena projects is reduced from 47 pct. to 9 pct. after adjustment, and for NCE projects from 43 pct. to 17 pct. One possible explanation may be that research institutions have a long tradition for R&D collaboration and participation in a cluster project does not play a significant role for developing their network. This is neither an objective for the cluster program.

Comparing Arena with NCE, we can conclude that members of projects at both program levels were active in R&D collaboration prior to participation in a cluster project, but participation in a NCE (incl. GCE) project seems to result in higher growth in collaboration than Arena projects.

5.3 Changes in collaboration intensity

Looking at the average number of R&D projects connected to each unique link between collaborators (collaboration intensity), it is apparent that the

Table 5.4

R&D collaboration intensity¹ (number of R&D projects per collaboration) before and after enrolment in a cluster project

Collaboration	Types of links in R&D collaborative network ²					In total		
	Two firms in same cluster	Firm and R&D inst. in same cluster	Two R&D inst. in same Cluster	Two firms in different clusters	One member and one non-member	Mean	Max	With > 1 project
Arena								
Finished in period 0	1.08	1.17	1.00	1.11	1.06	1.06	4	5.4 %
Active in both, period 0	1.48	2.59	2.86	1.66	1.37	1.44	55	18.2 %
Active in both, period 1	1.96	3.77	4.20	1.82	1.55	1.67	59	26.4 %
New in period 1	1.23	1.33	1.24	1.13	1.15	1.16	18	9.7 %
NCE and GCE								
Finished in period 0	1.00	1.50	1.20	1.00	1.04	1.05	3	4.4 %
Active in both, period 0	1.59	1.69	2.60	1.14	1.19	1.28	18	11.9 %
Active in both, period 1	1.78	2.55	3.79	1.39	1.39	1.53	30	22.0 %
New in period 1	1.32	1.25	1.48	1.02	1.21	1.21	16	10.7 %

Source: Samfunnsøkonomisk analyse

1) If we observe the same link in more than one project (e.g. the same two firms collaborate in five different projects), the intensity of collaboration is greater than 1

2) Based on R&D projects with at least one cluster member involved

3) Share of links observed in more than one project

intensity of collaboration varies a lot dependent on the type of collaboration.

We observe the highest intensity in collaborations where a research institution is involved, i.e. either between a firm and research institution or between two research institutions in the same cluster (cf. table 5.4). Links that are active in both periods have the highest intensity, indicating that some of these links can be a result of a long term and stable collaboration resulting in many collaborative projects.³⁷ Interestingly, even for this group of well-established links, the intensity has increased from period 0 to period 1, implying that these actors have been involved in more and larger R&D projects after enrolment in a cluster project.

Comparing the intensity for new with existing links, we observe that the intensity of collaboration is lower for the former group of links. The main explanation is that new collaborations are often linked only to one project. It is, however, naturally, that it takes time to expand a new collaboration to more projects. Thus, the summarised results for all types of links confirm that new links (collaborations) collaborate on average on fewer projects. Further, the share of links observed in more than one project is much lower for new than for well-established links (but higher than for the links that disappeared after period 0).

Comparing Arena with NCE is more challenging in the case of collaboration intensity. While some forms of collaboration become more intensive among member of an Arena project, other types become more intensive for NCE members. However, both seem to impact the collaborative intensity positively.

An assessment of changes in collaboration based on data on formalised R&D collaboration is a relative strict delimitation. However, as mentioned above, since we observe changes in formal R&D collaboration it is reasonable to believe that there also have been some changes in informal collaboration. This is confirmed in our interviews with members of the seven cluster projects we have evaluated.

³⁷ Not surprisingly, it is a few large research institutions that are the main collaborators within these types of collaboration.

6 Significant impact on economic performance

The main objective of Norwegian Innovation Clusters is to contribute to value creation through sustainable innovation, by making clusters more dynamic and attractive, and increasing the individual firm's innovativeness. The network analyses above documented that cluster participants have increased their formal collaboration in research and innovation projects significantly after enrolment in a cluster project. However, to assess the cluster program's effectiveness, we should trace effects of the program on the participants' innovation activity and economic performance.

6.1 Increased innovation activity

There has been a marked increase in the number of SkatteFUNN³⁸ projects in recent years. If we compare growth in the number of projects managed by core members³⁹ of the cluster projects included in the evaluation with projects managed by others, it appears that the growth has been higher among the core members, especially members of a NCE project (cf. figure 6.1).⁴⁰

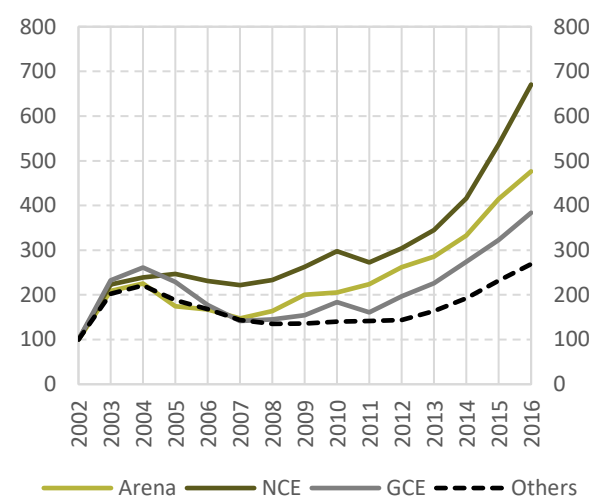
We are aware that the increase in the total number of SkatteFUNN projects (or at least applications) is partly because the Research Council has taken it upon themselves to mobilise firms to apply for SkatteFUNN. Unless the Research Council sees cluster participation as an indication of who to encourage to apply for SkatteFUNN this applies to all firms and should not undermine the observed difference between the core members and other firms.

Given that all firms engaged in innovation-oriented R&D are eligible applicants (see paragraph 4.1), we consider SkatteFUNN to be a good indicator of

firm's innovation activity. Our interpretation of the data is that the core members have a somewhat higher growth in innovation projects within the SkatteFUNN scheme, regardless of when they enrolled in a cluster project.

Figure 6.1

Number of active SkatteFUNN projects. Core members and others¹. Index (2002=100). 2002-2016



Source: Samfunnsøkonomisk analyse

1) Other recipients of SkatteFUNN (90 pct. of SkatteFUNN recipients are limited liability companies (LLC))

It is not clear whether the growth in use of SkatteFUNN can be attributed to participation in a cluster project. The significant growth in collaborative relationships (documented in Chapter 5), indicate that it could be the case. Further, our interviews show that the cluster projects have led to increased knowledge of and trust in each other among the members, and often, to a stronger cluster identity. This has increased the members' willingness to collaborate. Several respondents also state that the cluster project has increased their knowledge of funding agencies and the possibilities that exist for

³⁸ See discussion of the scheme in paragraph 4.1.

³⁹ See definition in paragraph 2.8.1.

⁴⁰ Core members are defined as such in all years. Hence, the increase in number of projects among these firms are not a mere result of an increase in the number of cluster participants.

cluster-based innovation. This has relatively consistently resulted in increased willingness to initiate, and capacity to conduct, innovation activities.

Regardless of whether the increased innovation activity is a result of cluster participation or not, we should expect this increase in innovation activity to affect the firms' economic performance. Given that most core members have received additional public support, both through SkatteFUNN and other supporting schemes (cf. Chapter 4), it is crucial to control for this additional support when we estimate the effects of cluster participation on firm performance in the following.

6.2 Significant impact on economic performance

Comparing core members in our sample with a matched control group, we find significant positive effects on employment, sales revenues and value added the first three years after enrolment in a cluster project. This is in line with previous and similar studies of effects of cluster participation (see Cappelen et al. (2015)).

In addition to confirming the results in previous studies, we have taken the established methods one step further in this evaluation to assess whether there are differences in the effects between the program levels and whether we can document heterogeneous effects.

6.2.1 All cluster projects

As part of their system for Management by Objectives and Results (MBR) and reporting to the ministries, Innovation Norway measures the economic effects of participation in a cluster project.⁴¹ The

measurements are carried out by Statistics Norway, and documented in Cappelen et al. (2015).

Cappelen et al.'s estimations indicate a higher growth in selected performance indicators among the firms in their sample the first three years after enrolment in a cluster project. After the first three years, there is no significant difference compared to firms in the control group.

The MBR method implemented by Cappelen et al. (2015) comprises the following performance indicators:

- employment
- sales revenues
- value added
- labour productivity
- return on total assets

In this evaluation we have chosen to estimate effects on the same (abovementioned) indicators. We also apply the same method as in Cappelen et al. (2015), i.e. the matching method with difference-in-differences (diff-in-diff) to compare the development of these indicators for firms participating in a cluster project (before and after the participation) with development of the corresponding indicators for firms in the control group.

Though the method and the performance indicators are the same, we make several adjustments in the choice of control group, and the presentation of results.

While Cappelen et al. use firms without support from Innovation Norway as controls, we allow both cluster firms and controls to be recipients of other types

⁴¹ See f. ex. Innovation Norway (2016) *Annual report to ministries 2016*, p. 263.

of public support. Using our database on all public schemes available for Norwegian firms (described in Chapter 4) we identify core members and potential controls with support from other public schemes. Not all public schemes are relevant for our analysis, thus we only include innovation- and industrial development-oriented schemes, as these schemes are also expected to affect our performance indicators. All core members, as well as potential controls are limited liabilities.

As in Cappelen et al. (2015), we use matching with stratification. That is, when searching for controls we look within groups (cells) with some predefined characteristics equal to the core members. In addition to specification of cells based on the firms' industry, region and cohort, we include an indicator of whether the firm has received additional public support or not.⁴²

Thus, we match the core members to firms from the same industry and region, that are established in the same year and with corresponding types of public support, but that have not participated in a cluster project.

Given that most core members have received additional public support (cf. Chapter 4), we believe that matching these with other firms with the same kind of public support gives us a more precise control group for interpreting effects of cluster participation. Not accounting for other types of support makes it difficult to claim that obtained effects are solely the result of cluster participation and not the result of other types of support.

With this approach, the only observable difference between firms in the treatment group (core members) and the control group is participation in a cluster project. However, this approach does not account for unobservable differences (e.g. qualities of the firm manager that could affect firm's performance). Further, both previous evaluations and our interviews emphasise the importance of the cluster facilitator's qualities for the project's success. We do not possess sufficient data on the latter to control for this. Hence, the obtained results do not necessarily represent causal effects and should be interpreted with caution.

The firm's characteristics at start-up, or in 2003 (or the first year of observation in our accounting data)

Table 6.1

Estimated average annual difference in ΔX between core members and control group. Matched difference-in-differences. All clusters. Percentage points

Dependent variable (X)	First three-year interval				Second three-year interval			
	Effect	z	[95 % conf. interval]		Effect	z	[95 % conf. interval]	
Number of employees	7.41***	6.64	5.22	9.60	-1.99	-1.11	-5.50	1.52
Sales revenues	12.74***	6.41	8.84	16.64	2.29	0.65	-4.62	9.20
Value added	8.06***	4.62	4.65	11.48	-4.07	-1.32	-10.13	1.99
Value added per employee	0.80	0.58	-1.89	3.49	-2.21	-0.88	-7.14	2.71
Return on total assets	-34.22	-0.42	-195.68	127.24	-34.00	-0.21	-344.68	276.69
Number of core members	460				229			

Note: 1:5 nearest neighbor matching with stratification by cohort-industry-region-other public support

*** p < 0.01; ** p < 0.05; * p < 0.1

⁴² This indicator comprises support from the Norwegian R&D tax credit scheme SkatteFUNN, innovation and development schemes in Innovation Norway, development support from the county municipalities and R&D

support from the Research council of Norway and EU FP7 and Horizon 2020.

for firms established before 2003, are used as matching variables, and include firm size measured as total assets and number of employees.⁴³ We use the same matching procedure as Cappelen et al., i.e. the Stata routine *psmatch2* with 1 to 5 nearest neighbor matching with trimming.⁴⁴

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 *is*). This is challenging when the time of treatment is not a fixed date, as in the case of cluster participation. A firm may be assigned to treatment early, or late, in its lifetime. We control for this by including an indicator for firm age at the year of treatment (here enrolment in cluster project) when estimating difference-in-differences. In addition, we control for the firm's location and the post-2008-crises and post-oil price-crises periods.⁴⁵

Table 6.2

Estimated average annual difference in ΔX between core members and control group. Matched difference-in-differences. Arena clusters. Percentage points

Dependent variable (X)	First three-year interval				Second three-year interval			
	Effect	z	[95 % conf. interval]		Effect	z	[95 % conf. interval]	
Number of employees	6.52***	3.6	2.98	10.07	-5.97	-1.6	-13.28	1.35
Sales revenues	14.72***	4.8	8.70	20.73	-9.06	-1.25	-23.22	5.10
Value added	8.89***	3.34	3.67	14.10	-11.75*	-1.84	-24.26	0.76
Value added per employee	1.67	0.79	-2.46	5.80	-5.97	-1.11	-16.56	4.62
Return on total assets	0.60	0.12	-9.19	10.40	-0.60	-0.05	-25.12	23.93
Number of core members	202				87			

Note: 1:5 nearest neighbor matching with stratification by cohort-industry-region-other public support

*** p < 0.01; ** p < 0.05; * p < 0.1

Table 6.3

Estimated average annual difference in ΔX between core members and control group. Matched difference-in-differences. NCE clusters.¹ Percentage points

Dependent variable (X)	First three-year interval				Second three-year interval			
	Effect	z	[95 % conf. interval]		Effect	z	[95 % conf. interval]	
Number of employees	7.30***	4.22	3.85	10.75	-0.98	-0.4	-5.74	3.78
Sales revenues	9.67***	2.66	2.56	16.78	5.97	1.21	-3.70	15.63
Value added	7.11**	2.40	1.31	12.92	-2.85	-0.68	-11.10	5.40
Value added per employee	1.01	0.44	-3.55	5.57	-2.42	-0.71	-9.10	4.26
Return on total assets	-32.03	0.18	-377.68	313.62	-66.36	-0.26	-563.01	430.29
Number of core members	139				94			

Note: 1:5 nearest neighbor matching with stratification by cohort-industry-region-other public support

*** p < 0.01; ** p < 0.05; * p < 0.1

1) Only NCE cluster projects that primary started out as NCE (and not as a successor of an Arena cluster project)

⁴³ Our accounting data starts in 2003. We do not possess information on firms' ownership structure, so unlike Cappelen et al. we are not able to construct the Herfindahl index for the owner concentration. However, in addition to total assets we use firm size measured by number of employees. Correlation between number of employees and total assets is low and does not imply multicollinearity problem.

⁴⁴ The option specification used is the same as in Cappelen et al. (2015): *neighbor(5) common trim(10)*, but as described above, the cell definition differs, as well as the matching variables. Thus, our results may differ.

⁴⁵ All diff-in-diff models are estimated using the mixed command in Stata (see http://www.stata.com/bookstore/stata12/pdf/xt_xtmixed.pdf).

Pooling all cluster projects, we find significant positive effects on employment, sales revenues and value added the first three years after enrolment in a cluster project. After the first three years, however, there is no significant difference between the core members and firms in the control group. For productivity and return on total assets we do not find any significant effects (cf. table 6.1). These results are in line with the results in Cappellen et al. (2015).

6.2.2 Differences between program levels

While Cappellen et al. (2015) only control for participation in any cluster project (by binary indicator, i.e. participation or not) and report average results for all participants, we test whether the results differ for different levels of the cluster program by grouping firms by Arena and NCE.⁴⁶

The results for all cluster projects presented above, hold when dividing the projects by their program level; i.e. significant positive effects on the same performance indicators the first three years after enrolment for both Arena and NCE projects.

Comparing Arena projects with NCE, we observe higher growth in sales revenues and value added for core members in an Arena project than for core members of a NCE project, compared to their respective control groups (cf. table 6.2 and table 6.3). The result is opposite for growth in employment. However, these effects are not statistically different from each other.

In addition to dividing members by cluster level, it would be desirable to estimate effects per cluster project. However, our preferred method requires a certain amount of data to provide consistent results.

For projects with few or no years of observable data in the period after the project was included in the cluster program, or project with few core members, it is not possible to carry out the abovementioned estimations. Thus, to assess the individual project's effectiveness we supplement the provided econometric analysis with several interviews with participating firms. These results are presented in the individual project reports.

6.2.3 Heterogenous effects

To elaborate the abovementioned results, we look at the heterogeneity of the effects for different indicators that are significant in the main analysis (i.e. number of employees, sales revenues and value added). That is, we check whether most of the firms experience positive effects or only a few firms that experience an extremely high growth and others none.

We check the heterogeneity of effects by ranging core members at the year of enrolment by the value of the variable of interest and define their "initial position". This procedure allows us to check whether core members in the highest quartile (top 25 pct.), with respect to their initial position, perform systematically different from the firms in the lowest quartile.

Our results indicate heterogeneous effect. That is, we find that small and medium-sized firms (at the time of enrolment) perform better than micro and large firms (cf. 2nd and 3rd quartile for the number of employees in table 6.4).

Apart from core members in the lowest quartile with respect to sales revenues at the time of enrolment,

⁴⁶ Includes member of two GCE cluster projects that started as NCE clusters (i.e. GCE Blue Maritime and GCE Subsea).

most firms seem to have increased their sales revenues after enrolment in a cluster project. This is in line with several of our interviews, where respondents argue that the cluster participation has initiated innovation or R&D projects they would otherwise not be involved in, which in turn has led to increased sales revenues.

Only core members starting out in the lower quartiles of the value-added distribution experience significant effects on value added after enrolment. A possible explanation for this result could be the so called “catching up” effect. The cluster projects may help firms that are far from the “best practice” to catch up with those who are close to the “best practice”.

The proven heterogeneous effects do not change our main conclusions. The “best” firms’, in terms of initial value added, participation in a cluster project

is still important for learning others how to perform better. In a recently published NIBR report that study the structure and performance in five clusters (not all cluster projects within the cluster program) the authors document how crucial participation of well-established and successive firms are in a cluster. These firms are forwarding ideas, bringing network contacts and pushing start-ups and immature firms to a new level. While they only observe a growth in employment for start-ups, they conclude that “(...) *both the older and newer firms report a high level of innovation*” (Onsager, et al. 2017).

Table 6.4

Heterogeneity of participation effects by distribution of dependent variable (X) at the time of enrolment in the cluster project. All clusters. Percentage points

Dependent variable (X)	Quartile	Mean of X	Effect	z	[95 % conf. interval]	
Number of employees						
	1	1	-9.06*	-1.87	-18.54	0.43
	2	5	17.28***	4.29	9.39	25.17
	3	13	14.76***	3.69	6.92	22.60
	4	88	6.81*	1.82	-0.52	14.14
Sales revenues (NOK 1,000)						
	1	347	-6.36	-0.59	-27.59	14.87
	2	4,098	32.02***	4.12	16.78	47.25
	3	19,617	17.03**	2.28	2.39	31.67
	4	224,659	20.63***	2.80	6.21	35.05
Value added (NOK 1,000)						
	1	79	31.85**	2.11	2.30	61.40
	2	2,106	22.30***	3.07	8.06	36.53
	3	9,119	10.11	1.50	-3.13	23.35
	4	76,515	11.53*	1.75	-1.38	24.44

Note: 1:5 nearest neighbor matching with stratification by cohort-industry-region-other public support

*** p < 0.01; ** p < 0.05; * p < 0.1

7 Linkages to the rest of the economy

The impact of the cluster program and the individual cluster projects on the local, regional and national economic activity could be greater than only the direct effect estimated in the previous chapter. As sales revenues and value added among the core members of the clusters increases, these firms demand more inputs to their production. That is, firms purchase goods and services from others. In addition, most firms have employees, who spend their wages on goods and services from local, regional, and national suppliers.

In this chapter, we will analyse how the core members⁴⁷ are connected to other industries in the economy, and to what degree increased value added within the cluster projects result in increased value added in other industries in the economy.

To do this, we conduct an economic ripple-effects analysis for the core members in all 47 cluster projects at a national level. Further, we have studied how the seven cluster projects subject to individual evaluation⁴⁸ differ from the national analysis and how they differ from each other.

7.1 Economic ripple-effects analysis

An economic ripple-effects analysis attempts to measure or estimate changes in economic activity in a specified region, caused by a specific economic event. In this analysis, the specific economic event is the public support of cluster projects in the cluster program.

The sources of the impact can be decomposed into different components, direct, indirect and induced effects;

The *direct effect* is the effects which can be identified as a result of the activities funded by the cluster program. Thus, the direct effects consist of value added among the core members in the supported cluster projects, estimated above.

Core members of the cluster projects, benefitting from the participation, will subsequently increase their spending on goods and services from other firms which will create additional activity in the local or regional economy. *Indirect effects* are thus the result of business-to-business transactions indirectly caused by the direct effects.

The *induced effects* are the results of increased personal income or increased capital return caused by the direct and indirect effects. Firms experiencing increased revenue from the direct and indirect effects will increase their payroll expenditures (by either hiring more employees, raising salaries, increasing payroll hours, etc.). Households will, in turn, increase their spending on goods and services from local suppliers. The induced effect is thus a measure of the increase in household-to-business activity.

However, it is not clear how to measure relevant induced effects. In principle, relevant induced effects will result from productivity growth in the economy as a whole (cluster members grow at the expense of other firms as discussed in Chapter 3). Whether this is a measurable effect is, however, uncertain. The purpose of this analysis is more modest and will only examine how the core members of the cluster projects are related to other industries in the economy. Thus, we ignore the induced effects in the following.

⁴⁷ See definition in paragraph 2.8.1.

⁴⁸ Arena Biotech North, Arena Lønnsomme vinteropplevelser, Arena Smart Water Cluster, NCE Instrumentation, NCE Micro- and Nanotechnology, NCE Raufoss and NCE Systems Engineering

7.1.1 How to interpret the results

The results from this analysis should be interpreted as a study of how the cluster projects are interconnected with other industries in the economy. It is difficult to determine to which degree increased value added among the core members is a result of higher productivity and/or higher export intensity, and hence leading to an effect for the Norwegian economy, or if the increase is a distribution effect that only reallocates resources from other industries.

Further, there is a difference between net and gross ripple effects. Gross ripple effects do not consider that labour and capital can be used elsewhere in the economy, i.e. not measuring the alternative use of labour that may potentially be greater elsewhere. This applies to both the direct and indirect effects.

To illustrate, the value of a new employee depends on the alternative use of the labour force. A new position is most valuable if it is filled by an unemployed and is less valuable if the new position displaces another position, in the sense that it contributes to reduced employment in another company.

When estimating net ripple effects, on the other hand, the employment and value creation that labour and capital can create elsewhere is deducted. Net impacts are particularly relevant in economies where unemployment is low, or it is difficult to import labour from other regions or countries. In socioeconomic net-benefit analyses it is common to assume full employment in Norway, that is, everyone who wants to be employed is already employed. On a national level, this means that measures that create new jobs is essentially distributional effects from

other industries and that the socio-economic gain is potentially marginal.

On the other hand, at a regional level it is not unusual to assume that there is a local mismatch between labour supply and labour demand in the labour market. Measures that affect the regional labour market could lead to more people being employed, and the potential for net ripple effects is greater at a local level than a national level.

In our calculations, we study the gross ripple effects. Consequently, the results do not provide a basis for concluding that we have a significant effect on value added on a national level.

7.1.2 Modelling economic impacts

The ripple-effects analysis is conducted by using Samfunnsøkonomisk analyse's own model SAR-MOD⁴⁹. SARMOD is an input-output model that analyses the indirect effects, based on how the industries (i.e. the industries that the core members are part of) within the clusters are linked to other industries in the economy. The model relies on inter-industry data to determine how effects in one industry will impact other sectors.⁵⁰ In addition, the model estimates the share of each industry's purchases that are supplied by national firms and the share that is imported.

As described in Chapter 2 clusters are both geographically and industrially diversified. The core members in all projects included in the evaluation represent firms from several regions in Norway, whereas each of the seven cluster projects represent a smaller region. Further, the group of all cluster projects and the seven regional cluster projects

⁴⁹ Samfunnsøkonomisk analyse's RingvirkningsMODell

⁵⁰ The model uses the ESA Questionnaire 1500 – Supply table at basis prices, including a transformation into purchasers' prices and ESA Questionnaire 1600 – Use table at purchasers' prices

will differ by which industries the core members represent.

For this analysis, we have composed a “synthetic industry” based on the composition of the core members of the specific cluster projects. Since the clusters are composed by different industries, the ripple effects of an equal value-added effect will consequently differ in magnitude. There are two main reasons to this difference.

Firstly, industries differ in the share of input in their production. For example, for a given production level, “Manufacture of basic pharmaceutical products” has an input level⁵¹ of 85 pct., while “Architectural and engineering activities” has an input level of 49 pct. Thus, the first round of ripple effects to other industries are presumably smaller in “Architectural and engineering activities”.

Secondly, the products that is demanded in the production process may differ in import intensity. For example, if an industry demands products that are produced in Norway the ripple effects are greater than if the products are imported.

The next aspect to consider in a study of ripple effects are which regional dimension to examine. In the analysis of all core members we have applied a national perspective, thus quantifying the ripple effects in Norway.

We have chosen a stylised example to illustrate the ripple effects of an increase in value added among core members in the 47 cluster projects. In addition, we study how the magnitude of national ripple effects differ between the different cluster projects.

Our stylised example examines the ripple effects of an increase in value added from cluster participation of NOK 10 million. We have applied the same stylised shock when analysing the core members in all cluster projects and the seven different cluster projects. The results presented here is thus not applicable to quantify the value creation in the rest of the economy of increased spending on cluster programs in general. However, it is useful to qualitatively discuss how identified effects on core members’ value added might lead to higher economic activity in the region. For comparison we do the same exercise on the industries in the private sector⁵² in the Norwegian economy.

Finally, we have not taken into account that some of the increased demand for goods and services may be subcontractors who are also members of the cluster projects themselves. If this is the case, we overestimate the ripple effects.

7.2 High interconnection with other industries

Our results show that the core members in our sample have a strong interconnection to other industries. An increase in the core members value added by NOK 10 million gives additional indirect ripple effects of about NOK 9.9 million in other industries in the Norwegian economy (cf. figure 7.1). The calculation is an upper estimate of the ripple effect (as discussed above).

An increase in the core members’ value added has a significant impact on value added in other industries in the economy. In numbers, a presumed increase in value added of NOK 10 million will give rise to a demand of intermediate inputs worth NOK

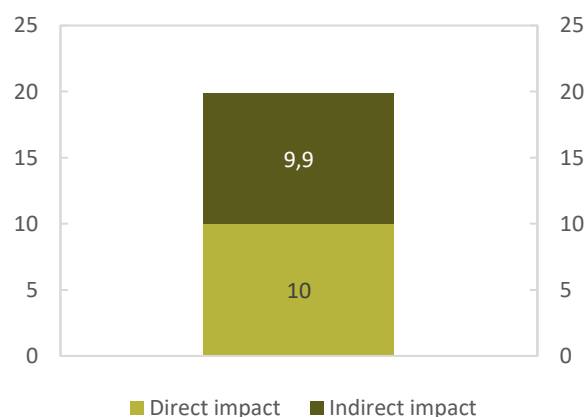
⁵¹ By input level we mean the share of intermediate input at a given production level, i.e. production (gross output) = value added + intermediate input.

⁵² Industries in the private sector with NACE ranging from 1 to 82. The value-added effect is evenly distributed on the industries.

19.4 million.⁵³ This demand of inputs will be directed to firms in all industries in the economy (members of the cluster projects but mainly from other parts of the economy). By exploiting our ripple effects model SARMOD we have calculated that NOK 9.8 million of the inputs will be imported, while NOK 9.9 million is gross product in industries located in Norway. The latter is the indirect effect.

Figure 7.1

Ripple effects of a NOK 10 million increase in value added among core members



Source: Samfunnsøkonomisk analyse

7.2.1 Comparison with average in the economy

By doing the same exercise for all industries in the private sector⁵⁴ in the Norwegian economy we find that the overall ripple effects are slightly lower. An increase in value added of NOK 10 million⁵⁵ gives additional ripple effects of about NOK 9.2 million. This shows that an increase in value added for the core members in all cluster projects generate slightly higher indirect ripple effects than if the same increase in value added is divided evenly on all industries in the private sector.

Our analysis leads to two main conclusions about the core members' interaction with the rest of the Norwegian economy:

- The core members are in general more intensive in their use of intermediate inputs
- The core members have a higher share of imports

These two results go in opposite direction; higher intensity of intermediate inputs increases the indirect ripple effects while higher share of imports reduces the indirect ripple effects. Overall, the core members' ripple effects are slightly higher than the average in private sector.

7.2.2 Differences between the cluster projects

We have applied the same shock as above to the seven cluster projects subject for individual evaluation. The results show that the cluster projects differ in the magnitude of the ripple effects compared to the core members in all 47 cluster projects (cf. figure 7.2⁵⁶ and table 7.1). The reason for the variation is due to differences in the industry composition between the cluster projects.

Arena Biotech North has a high degree of national ripple effects. This is due to the cluster project's relative high share of members within manufacturing of food products that has a high intensity of intermediate inputs in their production. An increase in the core members' value added will thus lead to high demand for intermediate inputs from other industries. In addition, the share of imports is relatively low thus leading to high indirect ripple effects for this specific cluster project.

⁵³ To simplify, gross output = value added + intermediate inputs.

⁵⁴ Industries in the private sector with NACE ranging from 1 to 82.

⁵⁵ This is evenly divided with a value-added effect of NOK 137 000 for each of the 73 industries with NACE ranging from 1 to 82.

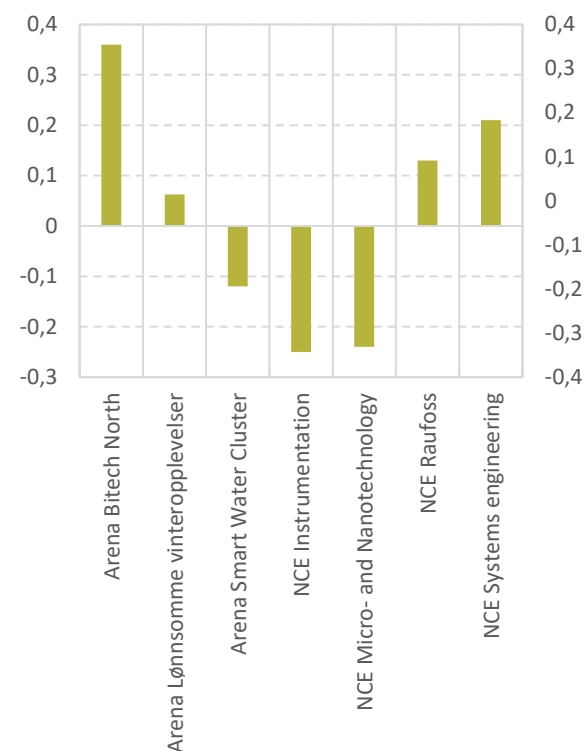
⁵⁶ The figure illustrates the ripple effects in seven cluster projects compared to the average of all cluster projects (all core members in all 47 cluster projects). A positive number means that the specific cluster project has relatively higher national gross ripple effects than the average of all core members, and vice versa.

Two other clusters projects with relatively high national ripple effects are NCE System Engineering and NCE Raufoss. NCE System Engineering consists mainly of core members within manufacturing of machinery and transport equipment, both having a relatively high intensity of intermediate inputs in their production. NCE Raufoss consists of core members within several different industries, mainly manufacturing of metals and motor vehicles, all having relative high intensity of intermediate inputs in their production. However, the share of imports is relatively high for both clusters, thus dampening the indirect ripple effects.

On the other hand, NCE Instrumentation's and NCE Micro- and Nanotechnology's core members have relatively low ripple effects to the Norwegian economy. These cluster projects consist mainly of core members within manufacturing of computer, electronic and optical products, which has a low intensity of intermediate inputs in their production. In addition, the share of import is relatively high leading to lower national ripple effects for these clusters.

Figure 7.2

Relative ripple effects in seven cluster projects compared to the average of all cluster projects



Source: Samfunnsøkonomisk analyse

Table 7.1

Gross ripple effects of an increase in value added of NOK 10 million. Numbers in NOK million

	Direct effect (value added)	Intermediate input from direct effect	Share of imports	Indirect effect (value added in)
Arena Biotech North	10	29.4	42 %	17.1
Arena Lønnsomme vinteropplevelser	10	18.9	41 %	11.2
Arena Smart Water Cluster	10	16.6	55 %	7.4
NCE Instrumentation	10	12.7	62 %	4.9
NCE Micro- and Nanotechnology	10	13.4	62 %	5.1
NCE Raufoss	10	25.0	50 %	12.4
NCE Systems Engineering	10	27.6	49 %	14.2
All core members	10	19.8	50 %	9.9

Source: Samfunnsøkonomisk analyse

Arena Lønnsomme vinteropplevelser is another project with relatively high ripple effects to the Norwegian economy. The cluster project mainly consists of core members within accommodation and tourism, and is characterised by a medium share of intermediate inputs. On the contrary, the share of imports is relatively low resulting in ripple effects to the Norwegian economy above average.

On the other hand, NCE Instrumentation's and NCE Micro- and Nanotechnology's core members have relatively low ripple effects to the Norwegian economy. These cluster projects consist mainly of core members within manufacturing of computer, electronic and optical products, which has a low intensity of intermediate inputs in their production. In addition, the share of import is relatively high leading to lower national ripple effects for these clusters.

Arena Smart Water Cluster has relatively low ripple effects to the Norwegian economy. The cluster project mainly consists of core members within manufacture industries, and is characterised by a medium share of intermediate inputs. In addition, the share of imports is relatively high resulting in ripple effects to the Norwegian economy below average.

In this evaluation, we have studied how the seven cluster projects interact with the rest of the Norwegian economy if the cluster projects had the same characteristics as the average of the industries they represent.

The degree of regional ripple effects will however depend on the characteristics of the specific cluster project. First, the regional ripple effects depend on the share of intermediate inputs that are demanded from regional industries. This will dampen the regional ripple effects. On the extreme, if all intermediate inputs are imported from outside the region, the regional ripple effects are zero. Secondly, the

core members within the cluster projects could have different characteristics than the average of the industry they belong to, both regarding the level of intermediate inputs (for a given production level) and share of imports from abroad. Unfortunately, we do not have sufficient data to conclude on these perspectives.

8 Assessment of organisation and operation

One of the main objectives of this evaluation is to assess whether changes in organisation and operation of the cluster program has contributed to the program's relevance, effectiveness and efficiency. Thus, in this chapter, we assess the efficiency of the cluster program. That is, we discuss the selected organisational and operational choices that have been made within the program and whether these choices promote or inhibit the results the cluster projects may potentially achieve.

An assessment of the extent to which our documented effects of the cluster program justify the total public funding of the program is done in Chapter 9.

8.1 Organisational changes

With the implementation of Norwegian Innovation Clusters (NIC), several organisational changes have been made, compared to the two previous cluster programs. Today's organisation and operation of the program is presented in Chapter 2. In the following we give a brief assessment of the most important changes, as well the program ownership.

8.1.1 Reintroduction of the advisory board

The current arrangement with an advisory board was introduced in the fall of 2013, i.e. prior to the introduction of the new cluster program. A similar arrangement had been in place up until 2009, for Arena and NCE.

The board *advises* the owners on the program's strategic development and dispositions, e.g. the board participates in assessing applications for new cluster project, as well as assessments of existing cluster projects. The board do not have decision-

making authority in what to be done with the individual projects. However, their assessments have a disciplinary effect.

It is our impression, from interviews with operators of the cluster program, that the arrangement with an advisory board has worked very well, especially in the first phase after the implementation of Norwegian Innovation Clusters.

8.1.2 Introduction of regional account managers

Our review of different cluster programs in Europe reveal that there has been an increased focus on professionalisation of cluster organisations.⁵⁷ This also seems to apply for the Norwegian cluster program.

The evaluation of the Arena program (Jakobsen, Iversen, et al. 2011) pointed out that there were significant regional differences in Innovation Norway's efforts towards the cluster projects. Thus, in mid-2015, Innovation Norway went from having 20 people (at their district offices) working part-time with follow-up of the cluster projects (in addition to other tasks) to nine regional account managers in full-time positions. The regional account managers participate in an advisory forum (network) with monthly meetings.

It is our assessment that the introduction of regional account managers in full-time positions must be seen as an efficiency improvement and professionalisation of the program operation. The regional account managers follow the clusters closer and are more active than before.

However, some task that were previously managed centrally are now transferred to the regional account

⁵⁷ See Chapter 10.

managers, e.g. the so-called “learning arena”, which were gatherings on different topics where all clusters could participate, regardless of cluster level. The regional account managers have taken some responsibility to arrange regional learning arenas, but it is our impression that not everyone see this as the best solution.

8.1.3 Introduction of one comprehensive program

The merger of Arena and NCE in one join program and the introduction of the third program level, Global Centres of Expertise (GCE), was perhaps the greatest change when the new cluster program was introduced. The merger of the two previous cluster programs to one comprehensive program is in line with the recommendations following the evaluation of NCE (Econ Pöyry and Damvad 2011), suggesting that a more formal link between Arena and NCE would contribute to a significant simplification and improvement in selecting new NCE projects (see Chapter 2).

We do not have grounds for saying that the selection of new NCE clusters is simplified or improved by the merger of the two programs. However, it is our impression that the overall selection of new cluster projects has improved. Instead of individual calls for proposals for each cluster level, there is now a common call for proposals. It is not predetermined how many cluster projects per level that will be included in the program. That is, it is the quality of the cluster project (substantiated in the application) that determine what kind of cluster projects are chosen, within the budgetary constraints. This has increased the flexibility in the selection of new cluster projects. A more thorough assessment of the actual selection criteria is given below.

With the introduction of Norwegian Innovation Clusters there have also been some changes in the offer of professional services through the program.⁵⁸ Prior to the new cluster program, some of the services (e.g. professional and project management gatherings) were separate for the two cluster programs. Due to significant differences in maturity between individual clusters, especially Arena clusters, this was unfortunate in many contexts. Thus, most professional services are now offered across cluster levels.

Our interviews indicate that the latter change has had positive effects. For mature facilitators (project managers) of mature Arena projects, gatherings with NCE clusters is likely to be more relevant than participating in gatherings with less mature Arena projects. Further, for the facilitators of NCE clusters, gatherings with facilitators of Arena clusters, which they may not have previously met, may as well be inspiring and motivating.

It is our assessment that the merger of Arena and NCE in one comprehensive program has mainly had positive effects. However, it may be that a joint program increases the cluster projects' expectations for continuation at the next cluster level (mainly for Arena clusters). We discuss this as part of the assessment of exit strategies below.

8.2 Tripartite ownership

Norwegian Innovation Clusters is jointly owned by Innovation Norway, the Research Council of Norway and Siva. Based on this evaluation we have no reasons to suggest that there should be made changes in the program ownership.

⁵⁸ See paragraph 2.6 for a presentation of the different professional services.

Norwegian Innovation Clusters is part of an interaction with schemes that have complementary function, by supporting research and innovation collaboration within regions and/or sectors (Innovation Norway, Siva and the Research Council of Norway 2012).

This evaluation shows that there is significant interaction with other schemes. That is, members of cluster projects with support from the cluster program are frequent users of other schemes, including schemes offered by all three owners.⁵⁹

In the outline of the new cluster program, the owners stated an ambition to reinforce connection to surrounding schemes to trigger more research and innovation activity in the clusters. We believe that this requires a collective effort from the three owners and it is our assessment that this alone serves as an argument for a continuation of the current tripartite ownership.

8.3 Sufficient selection criteria

Norwegian industrial policy is based on the belief that public schemes should be industry neutral. That is, the government should not define which industries that are "tomorrow's winners". In practice, however, different industries differ in their usage of public schemes to a large extent. Both the Research Council, Innovation Norway and others support some industries more than others, based on the objectives of the different schemes, the applications and assessments of the potential of each project.

The industrial distribution of the cluster projects' core members (see Chapter 2) show that Norwegian Innovation Clusters is not industry neutral in

practice. As part of an industry policy assessment, it may be discussed whether the allocation of cluster projects has contributed to preserving an industry structure, rather than promoting conversion. The discussion is relevant because several of the supported cluster projects gather firms with the petroleum sector as their main market. To meet the challenges we face, Norway needs the country's industrial expertise to contribute to increased growth in other export industries than petroleum. This issue has become even more important after the fall in oil prices in 2014.

In line with the need for growth in industries outside the petroleum sector, it can be argued that Norwegian Innovation Clusters should prioritise non-petroleum-related cluster projects in a greater manner. Changes in the industrial distribution among core members in recent years (see Chapter 2) indicate changes in this direction.

Identification of clusters can be top-down, bottom-up or a combination of the two (OECD 2007). Countries identify potential programme recipients mainly through two contrasting approaches: either (1) a statistical method, such as a mapping study, or (2) a process of self-selection, such as a call for proposals. The former is particularly used when the objective is to support national economic drivers. Norwegian Innovation Cluster represents the latter.

Our assessment is that this poses too high requirements for the program in deciding which projects to be selected. An important feature of Norwegian Innovation Clusters is that program places strict demands on the applicants (cf. Chapter 2). The criteria are designed to be a combination of objective data about the firms and an assessment of the cluster

⁵⁹ See Chapter 4.

project's market positions and potential for innovation.

When the selection criteria emphasise objective data, there will always be a bias towards firms and industries that have so far demonstrated a strong position or growth. The assessment of potential will naturally be based on this, but will add knowledge about market development and assessments of how a reinforced cluster organisation can help improve the collaboration in the cluster. External experts are brought in to assess the situation and potential.

It is difficult to see how to impose "rules" in the selection criteria stating that applicants with few links to the petroleum sector, but with weaker innovation potential, should get "extra points" in the selection of new projects. After a financial shock, like the fall in oil prices in 2014, it may seem wrong to have chosen so many petroleum-related cluster projects. However, at the time they were selected this probably seemed right and nobody can be perfectly forward looking. Further, our assessment of seven cluster projects does not substantiate that cluster projects without links to the petroleum sector have had more advantage of being part of the cluster program than those who have.

We recommend that the cluster program maintains the strict selection criteria to identify projects where it is most likely that a cluster facilitator can stimulate innovation collaboration, regardless of which sector the cluster belongs to.

8.4 Unclear exit strategies

Both theory and empirical results indicate the effects of public funding of cluster projects are greatest in the first years after the initiation of the pro-

jects. More precisely, our empirical analysis indicates positive significant economic effects of cluster participation the first three years after a firm enrol in a cluster project.

Part of the market failure that publicly supported cluster projects are supposed to correct is that the members initially do not have sufficient knowledge of, or are able to take into account, the gains resulting from closer collaboration on innovation and production of common goods.

However, the benefits of a common cluster organisation will become more visible to the members after a while. The benefits will also mainly be materialised in form of higher economic growth. Thus, it is reasonable to assume that the members will continue to support a cluster facilitator even though public support ceases after a few years, provided that the services the facilitator provide are perceived as relevant and create results.

In the final phase of the project the project facilitator must plan how the collaboration will continue without funding from the program. This is referred to as the project's exit strategy, which must be prepared no later than six months before the contract with the cluster program expires. However, the cluster program's multi-level system gives incentives to both the cluster facilitators (for their own sake) and the cluster members to position themselves for the next level at the end of the project period.

From the cluster facilitator's point of view, positioning for continuation makes sense to increase the likelihood of continuing of further developing activities. Nevertheless, the positioning for further public funding may affect the development of innovation-related collaboration the members are willing to finance, even when the project do not receive public

support. If too many cluster projects rely on continued public funding, the impact of the program will decrease over time.

Based on interviews and previous evaluations, our opinion is that most cluster projects use quite a lot of energy and effort on positioning themselves for continued public funding. The problem seems to be greatest when the cluster project is a NCE project. In these cases, the project facilitator has been funded for several years. It is thus difficult to see that the members have, over time, not become aware of the benefits of continued funding through membership fees.

Problems may arise if the cluster constitutes a substantial part of a region's business community. The cluster facilitator may then be tempted to appeal to regional political actors to work politically for continued support, with the risk that some are willing to ignore the criteria for continued funding. Such situations cannot be excluded in practice, and if so, it will weaken both the ability to fund new cluster projects and weaken the selection criteria.

Arena projects do usually not constitute a large share of local economies, which give somewhat different implications for their exit strategies. It can be assumed that new, immature clusters need more time to achieve a large enough mass of members and sufficient collaboration among them to no longer need external assistance to organise the cluster. However, it is not obvious that there is a need for public support beyond 3+2 years. In this case, extension to NCE must be justified by the need to promote common goods that are demanding to realise without public support. Such measures

may include the establishment of research or educational institutions, laboratories or other types of knowledge infrastructure that will benefit all.

Our assessment is that it would be better if it was clear from the outset of the project that further funding after the end of the project period is not an option for NCE projects, and only in exceptional cases for Arena. In that case, the difference between NCE or Arena projects will depend on what type of cluster they are initially, e.g. how established the clusters are. Clusters with already established common identity and knowledge of each other (relational basis) may more than newly established clusters need assistance to organise development of common goods. Newly established clusters will need more assistance to simply establish arenas for collaboration. The selection criteria should clarify that development of different kind of public goods important for the members requires more long-term efforts than the development of arenas for collaboration.

8.5 The facilitator is important for the results⁶⁰

Earlier evaluations of cluster programs have pointed out the importance of personal characteristics of the staff in the cluster organisation for the success of cluster projects. There is also a general agreement that the management of clusters – i.e., the execution of the role of cluster facilitator – requires more and other kinds of competence than a traditional development project.

One main reason is that the cluster facilitator must be able to communicate effectively with actors in several different arenas: a business arena with owners and managers of enterprises operating under conditions of market competition, a research arena

⁶⁰ This chapter is based on a similar chapter in Jakobsen and Røtnes (2011), but is updated with results from this evaluation.

with researchers and other actors operating in a world of universities and university colleges, and a political arena with bureaucrats and politicians. Mastering all these arenas requires a certain 'multi-lingualism'.

Another element that makes cluster projects demanding is that they are organized bottom-up, in the sense that enterprises and knowledge actors that are part of the project participate on a voluntary basis and can withdraw if they lose interest and belief in the project. A cluster organization therefore depends on continued legitimacy and commitment from its members.

Both earlier evaluations, and confirmed in this evaluation, document that there is a close relation between active participation and results in cluster projects: The more involved enterprises are in activities, the more they benefit from the project. This underlines how important it is that the project manager has the ability to create excitement and enthusiasm, while also ensuring credibility and a long-term perspective.

Ingstrup (2011) discusses different types of cluster organization and claims that different characteristics are needed in connection with clusters in the start-up phase and more mature clusters. He lists three cluster facilitation roles:

1. Facilitators that mainly focus on the development of *favourable framework conditions* for collaboration in the cluster. Often, these clusters will be new. When this is the facilitator's primary task, it is of decisive importance that the cluster facilitator is able to act in line with the cluster's own values. In addition, the facilitator must have personal integrity and trust to handle different types of relations in a professional way.
2. Facilitators that mainly focus on supporting the development of *specific collaboration projects*

in the cluster. This type of task will often be important in more mature clusters. Here, characteristics like a certain humbleness (an attitude that takes care not to force one's own opinions into a facilitation process), flexibility (openness to changes in thinking and processes) and an awareness of one's own influence will be important. The facilitator needs to understand the power and control that his role entails and act in such a way that desired activities actually take place.

3. Facilitators that take on both of the roles described above.

In this evaluation we have interviewed members of seven cluster organizations. The facilitators could best be described as of type 2 and 3 above. Overall, the project managers received good evaluations. However, it is worth noting that one of the clusters had changed project manager several times. It is also the cluster with least positive achievement of its own objectives.

Based on the rationale of how cluster organization can influence the cluster members achievement, our evaluation confirm that the cluster project results come *via the active participation of enterprises*. With other words, the most important things the project manager can do in order to create results is to encourage the enterprises to allocate enough time and resources to active project participation.

In addition, earlier evaluation shows that the more sophisticated and established the business environments are, the more demanding the cluster facilitator's role becomes. Established environments engage in collaboration on a number of levels; from well-developed customer-supplier contacts to formal and informal meeting places outside the auspices of the cluster project. In established environments, it is a very demanding task for a publicly financed cluster facilitator to develop arenas that are

both relevant and offer collaboration which does not already exist by virtue of itself.

This evaluation confirms the demanding role for facilitators in established clusters. However, time helps. OECD (2007) points out that it takes time for new collaboration patterns to expand and public (partly or fully) funded facilitators can help make this happen. During time well-functioning clusters start to discuss more demanding common projects like enhancing the level of knowledge infrastructure. During time the NIC program has also developed arenas for sharing experiences between cluster facilitators and convey knowledge of best cluster practice. Improvement in use of Innovation Norway's regional offices have contributed positively to this. Innovation Norway have during the last three years allocated an *account manager* to each cluster project. The account managers offer advice and guidance during the application process and are responsible for funding and payments throughout the project period, as well as monitoring the projects' progress. It is our assessment that this work has contributed positively to the cluster results.

Each cluster project independently chooses its own project management. Innovation Norway and the NIC program administration, has few possibilities to influence the choice of facilitator other than through the selection of applicants to the program. Our assessment is that the program owners have high attention to the importance of choosing good facilitators for the individual projects and that this insight is taken into account in the selection process.

8.6 GCE lacks theoretical justification

Global Centres of Expertise (GCE) was introduced in 2014 with the establishment of Norwegian Innovation Clusters. GCE targets clusters with a well-functioning organisation, and with a well-established position within global value chains.

GCE has some similarities to the German go-cluster program, which aims to combine the most powerful innovation clusters in Germany. However, this program only provides limited financial support for the participating clusters; the only direct support to the clusters is distributed through a competition on measures to enhance the quality of the cluster management. Clusters can annually apply for cluster-specific-projects and a total of about NOK 4.8 million is allocated to the awarded projects, which is about half the annual budget for each GCE cluster.⁶¹

Due to the criteria for GCE funding, the applicants were cluster projects that already had received several years of funding from NCE. In practice, these cluster projects applied for funding up to 20 years (ten years as NCE and another ten years as GCE). We have not been able to find theoretical arguments for such a long period with public funding of cluster activities. Rather the opposite; Clusters arise because of geographic agglomeration of potentially collaborative firms to internalise ways to overcome market imperfections related to knowledge spillovers and economies of scale. Both which require geographical proximity.

According to theory presented in Chapter 3, cluster organisations (facilitators) can strengthen the dynamics of clusters by helping to increase:

⁶¹ See Appendix 2 for a detailed description of this cluster program.

- members' knowledge and confidence in each other,
- organizing innovation-enhancing collaboration and
- strengthening the cluster's knowledge infrastructure.

However, there is no theory that provides reasons for cluster facilitators (as facilitators) to get public funding over many years. Our empirical data add to this by clearly indicating that the cluster project's ability to increase the dynamics within the cluster is limited to "some years".

The establishment of three GCE projects in 2014 challenges this understanding. Thus, we have looked into what lessons we can draw from the existing GCE project's activities so far. We have not evaluated the existing GCEs as such⁶², but interviewed each project's facilitator and examined what results they report. Our understanding of the properties of the established GCE projects can be summarised as follows:

- a) They have all accelerated ongoing collaborative activities, due to increased resources from the cluster program
- b) They all have a facilitator that has a high degree of trust from members and who quickly catch up on members' and other local firms' needs
- c) The members have their main market within different parts of the petroleum sector and are consequently affected by the recent "oil crisis"

Point a) only proves that public support generates activity. The reason is, in principle, the same as for funding Arena and NCE activities. Had this been the only activity in the GCE projects, it is hard to see any

other reasons for GCE as an own program level, other than that the objective regarding "a global position" is more clearly formulated.

In the situation with falling oil prices, the cluster facilitators in the three GCE projects have proven to be very useful in contributing to new market openings and collaborative projects to convert the members' competence and knowledge applicable in new field. That is, point b) and c) indicate that funding through GCE have been very useful during a difficult transition period for important industries in the Norwegian economy. Due to facilitators' proximity to the firms (members), knowledge about their needs and the ability to quickly establish real restructuring projects, they may have reduced the conversion costs for both the members and the economy.

Crisis like the one mentioned above are sudden in their nature. The fact that the GCE projects has proven to be useful in the transition to new markets must be seen as a non-intentional (probable) gain. It illustrates that such business organisations can play an important role in special situations. However, the effect is not replicable, in the sense that it is not possible to support organisations with public funding solely to be prepared for a possible future crisis.

Due to increased and extended funding, the GCE projects has been able to commit to both new and further development of existing knowledge infrastructure (e.g. laboratories, educational programs, etc.). Better knowledge infrastructure can be characterised as a public good, which seldom (if ever) will be realised if left to the actors themselves. Even with public support, such investments usually re-

⁶² An evaluation of the three GCE projects is beyond the scope of this evaluation.

quire a long-term perspective to be realised. The latter is in favour of supporting cluster projects for several years.

Our assessment of the GCE project's work so far is that the rationale for a third program level is weak. Further, if the purpose was to promote the most powerful clusters the objectives could have been formed in line with the objectives of the go-cluster program. The three supported GCE projects have proven to be useful, but mostly due to unforeseen market changes, which alone is not a valid argument for a third level in the cluster program. Thus, we cannot see any reason for supporting more GCE projects within Norwegian Innovation Clusters.

9 Benefits exceeds the costs

Norwegian Innovation Clusters aims to promote and enhance collaboration activities in clusters. The government support the cluster activities by financing cluster facilitators and common activities in each cluster project. The program's cost can therefore largely be described as public support of (desired) organising activities.

In addition to financing cluster facilitators, there are costs associated with the administration of the program itself. The administrative costs at the program level are primarily related to application processes and approval of new cluster projects, as well as follow-up, dialogue with and guidance of project organisations at the project level. Both cluster facilitators and Innovation Norway, naturally, also have some costs associated with reporting and disseminating results to the ministries and the public.

Participants in the cluster projects have direct costs associated with membership fees⁶³ and costs of participating in the organised activities. These are costs each individual participant presumably considers lower than their own benefit of participating. In total, these costs can be estimated to be approximately as large as the public funding (cf. Chapter 2).

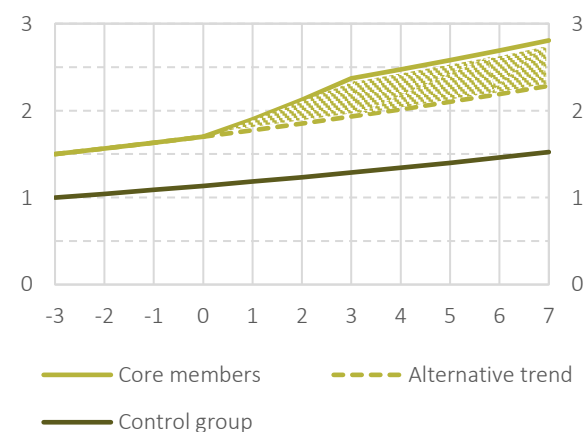
Whether the benefit of the public supported activities is higher than the social costs related to those activities depends on whether the additional value creation that the program entails exceeds the total public funding of the program and the members' costs.

A significant part of the economic gains that is attributable to the cluster program's activities accrues the participants in terms of wage and capital return,

but by far everything. For the overall economy, the main economic effect is the increase in productivity for all industries as a result of the cluster participants competing out firms with lower returns on available resources. This follows from the theoretical arguments presented in Chapter 3.

It is challenging to determine to what degree higher growth among cluster participants contribute to higher value added in the overall economy. However, based on the empirical analysis in Chapter 6, it is possible to estimate whether the additional value added resulting from participation in clusters supported by Norwegian Innovation Clusters exceeds the costs of the cluster program. If it does, it is a clear indication that the social benefit of the cluster program exceeds the social costs.

Figure 9.1
Development in value added for core members and comparable firms. Stylised example



Source: Samfunnsøkonomisk analyse

Our estimates indicate that core members of all cluster projects have on average 8 percentage points higher growth in value added the first three years after enrolment, compared to similar firms not

⁶³ The size of the membership fee varies between the cluster projects, and some pay nothing, at least not with monetary contributions.

participating in a cluster project. In the second three-year period after enrolment the growth in these two groups do not differ significantly. Our interpretation of these results is that the cluster projects enhance the core members' value added to a higher level, at which they remain (as illustrated in figure 9.1).

Though there are no additional effect on growth in value added after three years after enrolment, the total value added continues to be higher than what it otherwise would be. This is illustrated as the shaded area in the graph, which is the accumulated difference between the core members' actual value added at what it would be if they did not participate in a cluster project (the alternative trend).

To assess how long it takes for the benefits of the cluster program (measured as additional value added) exceeds the total (social) cost of financing the cluster program, we can calculate the development in marginal value added for a median core member of a cluster project and compare with the

social costs of the cluster program per core member.

Norwegian Innovation Clusters' annual budget for funding of cluster projects were on average NOK 103 million in the years 2006-2013.⁶⁴ In addition, costs associated to manage the program amount to almost NOK 20 million per year.⁶⁵ Thus, the total cost of the cluster program per 100 core members was NOK 45 million (we register about 2 200 active core members during that period).

Norwegian Innovation Clusters is a tax-financed program, which means that the social cost 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. With these adjustments, the social cost of public funding of Norwegian Innovation Clusters is estimated to be NOK 45 million * 1.2 = NOK 54 million per 100 core members.

Table 9.1
Marginal value added per 100 core members. NOK million

Years after enrolment	Development after enrolment ¹	Alternative development	Difference	Accumulated marginal value added
0	445	445	0	
1	497	464	33	33
2	555	484	71	104
3	620	505	115	219
4	647	527	120	340
5	675	549	125	465
6	704	573	131	596
7	734	598	136	732
8	765	623	142	874
9	798	650	148	1023

Source: Samfunnsøkonomisk analyse

1) 11.7 pct. increase in the first three years after enrolment, then 4.3 pct. as in the control group (based on the average of predicted rates). The value in year 0 is based on median value added for core members one year prior to enrolment

⁶⁴ See paragraph 2.5.2 for details on the annual budgets. Substantial increase in the number of core members in the years after 2013 (caused by introduction of GCE projects) creates some disturbances in the calculation

of marginal value creation. Thus, we have chosen to exclude these years in this calculation,

⁶⁵ From Innovation Norway's annual reports.

With our estimates on growth in value added for the core members after enrolment in a cluster project, the accumulated marginal value added per 100 core members will be NOK 104 million after two years (cf. table 9.1). That is, the additional value added exceeds the program's social costs after only two years. This also hold when we account for the members' own costs associated with participating in a cluster project. The additional value added in subsequent years must, in our opinion, be interpreted as a pure benefit to society.

However, it may still be a question of whether the program has reached a size that may lead to a situation where the growth in costs exceeds the growth in social benefits. It is particularly uncertain whether the increased long-term support of individual cluster projects enhance participants' value added sufficiently in the last part of the support period. We do not have data that can clarify whether the benefits of public funding for single cluster projects decline over time. However, our data point in that direction. Below we refer to certain factors that suggests that the support period for single cluster projects should be limited, compared to today.

We are aware that some cluster projects also receive public funding from the county municipality, but it is difficult to get an overview of how much this is accounts for annually. However, given limitations in the state aid rules and available funds, we do not believe these amounts will change our assessments of the costs significantly.

10 Lessons from international cluster programs

Norway is one of many countries in Europe that focus on clusters as part of their industry and/or regional policy. Cluster policies across Europe are wide-ranging, but they also have common traits. In this chapter we give a brief presentation of different cluster programs and approaches in Europe. A more detailed overview of these cluster programs is given in Appendix 1.

In addition to a brief review of various countries' cluster programs, we have looked closer into the cluster programs in three selected countries (Germany, Denmark and France). These case studies are presented in Appendix 2. Lessons from the three case studies are mainly used in our assessments and recommendations for further development of the Norwegian cluster program (see Chapter 10).

10.1 Cluster programs in Europe

Several countries and regions have cluster policies, programs and cluster initiatives. However, each location has its unique set of economic opportunities and challenges, hence policies need to be aligned with these local conditions and be delivered in ways that are consistent with the realities of the location.

The general focus among European cluster programs is to improve competitiveness by focusing on a specific cluster or group of clusters as regional agglomeration of economic activities in related fields and not of an individual firm, a specific industry, a broad sector, or the entire regional economy. Cluster programs establish a framework that enables implementation of cluster initiatives, allocation of funding, creating organisational responsibilities and defining the specific conditions to increase the competitiveness of the national or regional economy.

The prevailing ideas behind supporting clusters have been on the one hand fostering links among key national/regional actors especially connecting the research and business spheres that have been promoted as research and innovation clusters, and on the other hand stimulating economic growth of regional enterprises and SMEs labelled as business clusters and networks.

Most national and regional cluster programs launched in the 1990s and 2000s was inspired by the theories of Porter (see Chapter 3). Following Porter, the concept of clusters appealed to public policy makers and the identification, development and upgrading of clusters became an important agenda for governments. One reason for the success of Porter's theories was that his ideas focused on competitiveness, which responded to the concerns of policy makers (Martin and Sunley 2003). Scotland, the Basque country or Catalonia were among the first regions to embrace the concept of cluster development based on Porter's conceptual framework.

In some countries Porter's concepts have been applied together with other analytical frameworks. In Sweden the concept of "development blocks" was introduced first, by Dahmén (1989), who advocated that interdependence between firms and industries facilitates the diffusion of knowledge, encourages networks that strengthen businesses and is a source of development. Porter-based cluster analyses were carried out in Sweden at the end of the 1980s (Brandt, 2001).

Cluster policies in France (*grappes d'entreprises*) and in Italy have been very much influenced by the work of Giacomo Becattini who popularised the notion of the "Marshallian industrial district" in economic development. It was the 1980s, when a group of Italian economists rediscovered the importance

of industrial clustering as an opposition to the Fordist model (Becattini 1975, Brusco 1982).

In the Netherlands and Finland open innovation and innovation network theories resulted in a particular form of cluster support. In the Netherlands, the role of the government in cluster policy was seen from the very beginning more as indirect facilitator and catalyst of dynamic comparative advantages in the national innovation system (Roelandt and den Hertog 1999). In Finland a shift has been made from traditional cluster-based policy towards platform-based innovation, where open innovation and cross-sectoral collaboration are emphasised. In this open innovation platform approach, more focus is placed on fostering new combinations of knowledge and on co-creation with users than in the previous cluster-based policy that focused on building linkages between research and industry (Izsak and Romanainen 2016).

Following and complementing the report of the European Cluster Observatory (Meier zu Köker and Müller 2015) the following groups of countries can be differentiated related to national cluster policies and their respective programs⁶⁶:

- The first group includes countries such as Finland, Italy and the United Kingdom that do not have cluster programs at national level in place, but have cluster-based policies at regional level to different extents.
- The second group includes countries such as Austria, Netherlands and Spain that implement cluster policies at a regional level but also have put in place a national cluster, industrial platform or program.

- The third group includes countries such as the Czech Republic, Denmark, France, Germany, Greece, Latvia, Norway, Portugal, Romania and Sweden, which runs highly important cluster competitions at national level but also supports cluster development at regional level. Cluster policies at national level often target the top clusters or clusters of key strategic importance while the regional level funds emerging cluster activities.

A survey conducted by the European Secretariat for Cluster Analysis in 2012 revealed that grant funding was the prevailing support instrument of nearly all cluster programs. In terms of financing schemes, the program usually supports both cluster management structures and activities within clusters. Further, in several cluster programs significant parts of the budget for specific activities are dedicated to the cluster managements to develop new business support services.

In some countries, such as Germany, there is no funding to cluster organisations at national level (but to cluster activities), while in others funding of cluster organisations is highly relevant (such as Portugal). While cluster programs still use grant funding to support cluster organisations, more and more programs also provide a technical assistance for training and coaching of cluster organisations.

The common flagship words of cluster policies have been growth, jobs and innovation; however, they have been diverse in terms of their implementation mechanisms. Some focus on setting up cluster management structures while others implement cluster framework policies (by focusing on the creation of favourable business framework conditions).

⁶⁶ See Appendix 1 for more detailed description of the different cluster programs.

Some focus on the further development of mature clusters (raising them at world-class levels), while others focus on emerging industries. Some provide direct funding to cluster organisations while others provide labelling and support collaboration projects.

Depending on the developmental stage, it has been a common understanding that clusters have to receive corresponding tailor-made support through appropriate cluster policy measures. There is no “one-size-fits-all” policy or program, but the need to develop and implement different policies or programs addressing the different groups of clusters.

10.2 Recent trends in cluster policies

A wave of intensified interest in creative industries and clusters in the 2000s was to a large extent based on the work of Richard Florida. In his work “Creative Cities” and the “Creative Class” he highlighted that creative industries act as providers of cultural services that make certain cities attractive for a “creative class” of knowledge workers and their innovative employers.

More recently, cluster programs have been influenced by smart specialisation, regional branching and related variety theories. Jacobs (1969) wrote that variety within a region might matter for knowledge spillovers conducive to useful recombinations, but only if all the different industries in a region are technologically related to each other.

Theoretical advancements and the most recent economic and societal challenges has had an impact on the nature of cluster policies and still prevail today. Some of the concepts and analytical frameworks are also being further developed, such as cluster mapping. Nevertheless, cluster policy makers devote more attention to certain aspects that can be summarised in the following:

- Combining “strengthening strengths” with “encouraging structural change and the emergence of new industries”: instead of supporting only existing mature clusters, or focusing on only new emerging industrial activities, a need for a combined approach has been recognised.
- Focusing on an appropriate portfolio: instead of a narrow specialisation, cluster portfolio programs, where policy makers consider a well-selected group of clusters, encourage industrial diversification and stimulate cross-sectoral clustering is a future direction of cluster support.
- Encouraging “collaboration within clusters” and “improving the business environment for cluster development”: creating a better business environment in clusters and focusing on specific dimensions of the business ecosystem in addition to enhancing collaboration structures among national or regional actors.
- Integrating cluster policies into smart specialisation strategies (using clusters as a tool to implement RIS3): with the new EU incentivised smart specialisation strategies, some governments have built strongly on their existing clusters and cluster policies.

In recent years, a shift towards support of mature clusters (instead of creating new clusters) and the development of emerging industries can be observed, in particular for national cluster programs, but also increasingly for regional cluster programs (European Commission 2016).

One consequence of this is the focus on existing cluster organisations and better exploiting them for national and regional development (and using them to implement other policies such as research or trade policies). Only a limited number of programs, mainly on the regional level, supports the establishment of new cluster organisations. This also means that in some countries and regions well-developed

and strong cluster management structures are long-term, they are not supposed to be dismantled as such since they depend rather on the bottom-up industrial rationale than on top-down funding.

Besides this, it can be observed in several regions that there is a high interest in capturing promising emerging niche activities within clusters. There is a general recognition that certain sectors within the economy are internationally traded and strategically important for exports and investments, whereas others are generators of “local” employment or underpin other sectors; and a third broad group of emerging niches have the potential to drive increased value added in the economy (Izsak, Markianidou og Reid 2016).

Further, internationalisation and professionalisation of cluster organisations has been a new focus for several cluster programs. Cluster organisations are considered instrumental in helping local SMEs stepping out on international markets. Cluster excellence programs have spread in many countries with a focus on maximising the quality of support services offered by cluster management organisations.

10.3 International impact studies

The expected impact of cluster policies concern usually better business competitiveness, enhanced innovation capacity, SME development, more research and innovation collaboration projects and the uptake of innovations by the market.

Evaluations of cluster programs conducted across different European countries and regions are overall positive about the outcomes of supported cluster initiatives. The most recent analysis from countries such as France, Germany, Sweden and Denmark all conclude in general that firms within clusters out-

perform firms not operating in clusters. More specifically, the Scottish impact evaluations found that the presence and strength of industry clusters has a direct effect on regional economic performance. The Basque Country made its first efforts to evaluate the efficiency of their policies already in 1998 and found that cluster policy helped prioritising public resources and most importantly increased inter-firm relations. Further Basque cluster studies revealed that the analysed cluster management organisations had facilitated collaboration, generated trust and helped to share knowledge and experiences (Orkestra 2009).

The impact of clusters is related to regional development, firm performance, entrepreneurship and innovation. The following results and positive effects of participation in clusters have been cited in the abovementioned national cluster evaluation studies:

- Increased probability to innovate
- Increased R&D collaboration
- Catalysing the R&D&I system
- Increased competitiveness of firms
- Creation of more jobs and higher wages

Evidence from the US and Sweden shows that firms within clusters are more competitive. Wennberg and Lindqvist (2010) analysed firm-level data for all 4,397 Swedish firms established in telecom and consumer electronics, financial services, information technology, medical equipment, and pharmaceuticals from 1993 to 2002. They found that firms located in strong clusters create more jobs, higher tax payments, and higher wages to employees.

Similarly, the evaluation of the Walloon policy for competitiveness clusters, commissioned by the Walloon Institute for Evaluation, Prospective and

Statistics (IWEPS) found an increased R&D collaboration activity. However, it also revealed that the impact of cluster policy on mobilising investment projects had been weaker.

An impact assessment of the Innovation Network program in Denmark found that firms participating in the program tend to grow faster than non-participants. Further, the study showed that the effects of participation varies depending on prior experience of the innovation system. That is, firms with now prior involvement in the innovation system experience more profound result in the short run.⁶⁷

⁶⁷ See more detailed description in the presentation of the Danish cluster program in Appendix 2.

11 Recommendations

The main objective of this evaluation has been to assess to what extent Norwegian Innovation Clusters meets the needs of the target group, whether the operation and organisation of the cluster program is appropriate and whether the effects are in accordance with the objectives. That is, the task for this evaluation has been to assess the following:

- To what extent the market or system failure constituting the rationale for the program is still present and if and what alternative measures that exist to compensate for these failures (relevance).
- Whether the cluster projects have achieved their stated objectives and whether they collectively contribute to achieving their program level's objective and the cluster program's common objectives (effectiveness).
- Organisation and operation of the cluster program, including an assessment of whether changes in organisation and operation has contributed to the program's relevance, effectiveness and efficiency.

In this chapter we summarise our findings and provide our recommendations for further program development.

11.1 The rationale for the program is still present

Our review of different theories of how clusters occur and how cluster dynamics can be stimulated shows that the Norwegian Innovation Cluster has developed an instrument that is adapted to strengthen dynamic effects in Norwegian clusters.

It is important to distinguish between cluster effects, i.e. effects resulting from collaboration in clusters,

and effects of the cluster program. The cluster programs' role is to stimulate cluster development, or more specifically to *trigger collaboration-based development* which otherwise would not have happened, *and to reinforce and accelerate existing collaboration*. This is both about stimulating collaborative potential (relational basis) and specific collaboration processes.

It is our assessment that Norwegian Innovation Clusters is based on a solid academic basis and that there is reason to assume that the program activities should result in more collaborative activities, enhanced innovation, and subsequently increased value added, that would otherwise not have happened. However, we do not find a theoretical justification for a cluster program with three levels, potentially supporting cluster projects for 20 years.

11.2 The cluster program has significant impact

The Norwegian Innovation Clusters "(...) *aims to trigger and enhance collaborative development activities in clusters. The goal is to increase the cluster dynamics and attractiveness, the individual company's innovativeness and competitiveness.*"⁶⁸

Through extensive analysis, we believe that objective data substantiate that the Norwegian Innovation Clusters program achieve its objectives. We find that the cluster program enhances:

- Pride and relational basis among members of the cluster projects
- Collaborative research activities among members and members and others
- Growth in value added, employment and turnover

⁶⁸ <http://www.innovationclusters.no/english/>

Our data also indicate that the cluster program promote members' innovation activity, although this result is more unclear.

We summarise these indicators in more detail in the following.

11.2.1 Cluster status enhances visibility and pride

Programs such as Norwegian Innovation Clusters can lead to changes in firm behaviour just by announcing a call for proposals. When applying for admission into the program firms develop better knowledge of each other and search for new opportunities for collaboration. As a result, firms identify more with each other than before, desire to develop new meeting places, collaboration projects increase and, not least, the pride of belonging to an acknowledged industry environment is clear both among the firms themselves and in the local community they are part of. These results are clear from our interview, but is also confirmed by previous evaluations (Econ Pöyry and Damvad 2011, Jakobsen, Iversen, et al. 2011).

Acceptance into one of the cluster levels in the cluster program is not an automatic process. The application must be better than other applications. Thus, when a cluster project is supported by the cluster program it becomes visible as a business environment which the public authorities believe to have a particularly strong potential for growth. The cluster is assessed as a successful business environment and can, as a function of this, further develop its common identity as a cluster.

Interviews reveal that this positive attention contributes to an internal sense of pride, which in turn creates interest in contributing to the further development of the cluster project.

In addition, most cluster projects have chosen to use project funds for different kinds of marketing of the project and its members. The combination of positive attention from the status achieved and the profiling of the cluster in the aftermath of this has made several clusters more visible than they were before they were accepted into the cluster program.

Looking at data on allocations from various industry-based support schemes, members of the supported cluster projects are overrepresented among funding agencies offering export-, innovation- and research-oriented schemes. Further, data shows that the cluster companies have more eligible projects, but it may also be a consequence of more visibility. Our interpretation is that this is a result of more visibility, as well as an increased understanding of the benefits of various support schemes. The impact has probably also been enhanced by the fact that many cluster facilitators help the members in applying for relevant support.

The effect of the new status and attention has naturally been strongest for those clusters which were little known to start with and where the firms in the cluster during the initial years of the project have shown a continued positive development.

The positive attention following the acceptance into the program also helps to reinforce the work of the cluster facilitators in developing common collaboration arenas and infrastructure. Both interviews conducted in this evaluation and earlier evaluations show that the cluster members have a very positive attitude towards participating in and utilising organised meeting places, cluster-relevant education and training and incubators that are being developed.

The cluster program's impact on the cluster's visibility, pride and identity is, in our opinion, primarily an argument that supports the continued uptake of new

clusters in the program. However, the argument is conditional on the existence of positive effects on firm performance, as we find. If not, recognition and visibility could have been achieved in other and simpler ways (e.g. award ceremonies).

11.2.2 Significant growth in collaboration

Norwegian Innovation Clusters has a clear objective to enhance collaboration between firms in the cluster and firms and knowledge institutions. It is emphasised that market failures (referred to as system failures) “*limits firms' ability and willingness to invest in collaboration*”. Hence, stimulating firms to collaborate in innovation activities is a highly prioritised task.

In this evaluation we have analysed whether participation in a cluster project has had an impact on the firms' R&D collaboration networks. As our available data comprise detailed information about firms and research institutions that are engaged in different R&D projects we have been able to construct an R&D collaboration network for each cluster firm counting direct links between them and other R&D project collaborators. We have also constructed cluster networks, i.e. links between all firms and research institutions participating in the given cluster.

The results are striking. When we compare collaboration links before and after enrolment in a cluster, collaboration between cluster firms in the same cluster has been doubled in the Arena projects. Similar collaboration has more than doubled in the NCE projects. It is also a significant increase in collaboration between cluster firms and R&D institutions in the same cluster.

Based on the above, it is our clear conclusion that Norwegian Innovation Clusters contributes to more innovation-oriented collaboration between members of the cluster projects and between members

and R&D institutions. There is further reason to assume that this collaboration contributes to more innovation than would otherwise have been the case, although this requires a separate analysis.

Given that the objective is to strengthen innovation collaboration between firms and between firms and knowledge institutions, data supports that Norwegian Innovation Clusters should continue to fund cluster projects, regardless of cluster level.

11.2.3 Increased innovation activity

An important objective for the Norwegian cluster program, as well as for cluster programs internationally, is to strengthen innovation among the participating firms. The increase in innovation-oriented collaboration gives reason to expect this to happen.

We have no data that can directly measure the extent of firms' innovation activity before and after enrolment in a cluster project with support from the cluster program. However, the development in number of R&D projects with support from the Norwegian R&D tax credit scheme SkatteFUNN is closely linked to changes in firms' innovation projects. SkatteFUNN intends to stimulate R&D within all industries. All firms with an approved innovation project are eligible for tax credit. Thus, with an actual innovation projects there is no reason not to apply for tax credit.

We do find that the cluster members in our sample have higher growth in innovation projects within the SkatteFUNN scheme, than other firms. However, it is not clear whether this can be attributed to the cluster participation.

11.2.4 Significant economic growth

Comparing cluster members in our sample with a matched control group, we find significant positive effects on employment, sales revenues and value added the first three years after enrolment in a cluster project. That is, we have compared members of cluster projects with support from Norwegian Innovation cluster, with similar firms, not participating in a cluster project, regarding number of employees, geographic region and support from public schemes apart from the cluster program.

We do not find a significantly higher growth among the cluster members in the second three-year period after enrolment.

Our econometric results are in line with what we would expect from the theory of public support of clusters and the rationale for Norwegian Innovation Clusters. Our interpretation is that the cluster projects trigger unresolved dynamic processes in the respective cluster projects.

Our results are also in line with previous evaluations of participation in the Norwegian cluster program (Cappelen, et al. 2015) and evaluation of international cluster program, e.g. Innovation Networks Denmark. An evaluation of the latter showed that firms participating in the program tend to grow faster than non-participants. Further, the study showed that the effects of participation varies depending on prior experience of the innovation system. That is, firms with now prior involvement in the innovation system experience more profound result in the short run.

Based on the above, it is our clear recommendation that Norwegian Innovation Clusters continues to support both new and existing cluster projects. However, it is our interpretation that the cluster pro-

jects primarily have a “kick-off” effect. Thus, we recommend a more limited period of public funding of cluster projects that today, e.g. termination of Arena projects after three years and NCE projects after seven (3+4) years.

11.3 Positive changes in organisation

With the implementation of Norwegian Innovation Clusters (NIC) and in the years after, several organisational changes have been made. We consider both the reintroduction of the advisory board and the introduction of regional account managers as a professionalisation of the operation of the program. Further, we see the introduction of joint calls for proposals and the use of the programs’ professional services across cluster levels as an efficiency improvement.

Compared to the number of firms supported, the programs’ annual budget is relatively modest. Given our results on firm performance from participating in a cluster project, we find that the additional value added exceeds the program’s social costs after only two years. This also hold when we account for the members’ own costs associated with participating in a cluster project.

Our review of international cluster programs shows increased focus on industrial diversification and stimulation of cross-sectoral clustering. This is in line with our observed changes in Norwegian Innovation Clusters’ selection of new cluster projects.

Despite mostly positive organisational changes, one challenge remains. The cluster program is not clear on how public funding of different cluster projects should or will be tended. Several cluster organisations are positioning themselves to increase the likelihood of continuation in the cluster program.

From their point of view this is rational, but may inhibit the development of innovation-relevant collaboration that members want to finance even in the absence of public funding. If too many cluster projects are doing this, the overall impact of the program will diminish over time.

The problem seems to be greatest when the cluster project is a NCE project. In such cases, the project organisation has been funded for several years and it seems that they have difficulties seeing that, during these years, the members have not become aware of what benefits further membership funding will provide.

It is our assessment that the program will benefit from making it clear from start that funding beyond the agreed number of years is impossible at NCE level, and only exceptionally for Arena clusters. Our recommendation to not allow for continuation after an ended NCE project follows our assessment of GCE.

The three existing GCE projects have clearly shown that they initiate many relevant activities that are likely to be important for the further development of the clusters, and - not least - have been very important for the conversion process of the clusters. The latter has been important because the current GCE clusters are very closely linked to rapid restructuring of the oil and gas sector. However, we have not been able to find theoretical arguments for supporting cluster projects beyond the 10 years of support possible within NCE.

When we ignore the GCE clusters' (important) conversion efforts it is only the development of common goods, as enhancing their knowledge infrastructure, that really justifies the long-term support, but this can be supported through other, more targeted schemes.

11.4 Alternative use of funds

As discussed above we do not find support of long-term funding of cluster organisations in themselves. However, there is a need for more long-term support in situations where cluster organisations initiate larger common good projects that are of a size and complexity that takes a long time to realise. Examples of such common good projects are development of new knowledge or research institutions and test or laboratory facilities available for the whole cluster. Development of a better and more relevant knowledge infrastructure will clearly have the character of common goods that normally require public funding.

Our evaluation has revealed clear gains when the cluster projects manage to organise improvements in relevant knowledge infrastructure. However, it is not obvious that public funding of such activities should be limited to ongoing cluster projects.

It is our assessment that both established and new clusters, outside or within the cluster program, can help revealing which knowledge infrastructures that do not work optimally and what can be gained by establishing a long-term collaborative project to strengthen these public goods. If Norwegian Innovation Clusters establishes application-based funding schemes for such activities, the cluster program will help promote activities that firms can rarely promote on their own.

In practice, the above can be realised by expanding Sivas' newly launched Norwegian Catapult scheme as part of Norwegian Innovation Clusters, or creating something similar which also include efforts to strengthen clusters' knowledge infrastructure as part of the cluster program.

However, it is important that measures to support common good projects in clusters is application-based. Applications require that the applicant clarifies the project and allows for applications from more clusters than those who are part of the cluster program at the time of application.

The advantage of restricting eligible applicants to clusters (within our outside of the cluster program), that can document their organisation, is that it increases the likelihood that the project will be relevant to a large group of firms that have exposed their growth potential. Over time, it will probably be the clusters who continuously work to strengthen the dynamics of their own cluster that will win in such application-based competitions.

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Appendix 1: Overview of cluster programs in Europe

Cluster programme	Rationale/Objectives	Form of support	Number of clusters	Most recent priorities
National				
Denmark, Innovation Networks Denmark ⁶⁹ and Cluster Excellence Denmark	<ul style="list-style-type: none"> Strengthening the research, development and innovation activities of Danish companies Strengthening interaction between private companies and publicly supported knowledge institutions Cluster excellence Denmark is a national platform that collects information for cluster management organisations. 	<p>Support to innovation networks as cluster organisations that offer services to member companies such as:</p> <ul style="list-style-type: none"> Matchmaking and creating collaboration Initiating specific development projects Conferences, seminars Helping with fundraising Export promotion Cluster labelling according to ECEI 	Around 50	<p>Internationalisation of firms through clusters</p> <p>More professional cluster organisations</p>
France, Pôles de Compétitivité ⁷⁰	<ul style="list-style-type: none"> Extend the clusters' mission to bringing R&D projects to market Increase cluster support to SME ecosystems through contacts with investors, anticipation of skills needs, export capacity development Focus financing towards more productive clusters for a better efficiency of clusters' policy 	<p>Support to cluster framework policies enhanced by:</p> <ul style="list-style-type: none"> Granting financial aid to the best R&D and innovation platform projects via the single inter-ministerial fund (FUI), during calls for projects Partially financing the cluster organisations Providing financial support for thematic collective actions initiated by the clusters in a wide range of fields Involving various partners 	71 competitiveness poles	<p>Link to the "Future of Manufacturing" initiative</p> <p>Supporting industrialisation</p> <p>Internationalisation</p> <p>Access to private funding</p> <p>Skills development</p> <p>Links between SMEs and large companies</p>

⁶⁹ Innovation Networks Denmark. Available at: <http://ufm.dk/en/research-and-innovation/cooperation-between-research-and-innovation/collaboration-between-research-and-industry/innovation-networks-denmark>

⁷⁰ Les pôles de compétitivité, moteurs de croissance et d'emploi en France. Available at: www.competitivite.gouv.fr

Cluster programme	Rationale/Objectives	Form of support	Number of clusters	Most recent priorities
Germany, Leading Edge Cluster Competition ⁷¹ , Go-cluster programme, 'Internationalisation of leading edge clusters'	<ul style="list-style-type: none"> Strengthen cooperation between industry and science Make location more attractive – for skilled personnel, for investors and for those involved locally Internationalisation 	Support to cluster framework policies enhanced by: <ul style="list-style-type: none"> Enhancing research and innovation projects Development of cluster structures Improving cluster excellence Fostering innovative cluster support services 	15 leading edge clusters (selected in 3 rounds). The go-cluster programmes unite 92 innovation clusters from all German regions	Fostering research especially of SMEs (Mittelstand) Professionalisation of cluster structures Internationalisation Supporting cross-sectoral clustering
Czech Republic, Clusters - Cooperation ⁷²	<ul style="list-style-type: none"> Support of the cooperation of the clusters Internationalisation & Development of clusters R&D activities 	Support to innovation networks as cluster organisations that offer services to member companies such as: <ul style="list-style-type: none"> Funding Technical assistance in form of provision of training and consultancy services Initiating specific development projects Support to internationalisation Cross-clustering activities Cluster management excellence Cluster labelling according to ECEI 	Around 40 clusters listed in the NCA ⁷³	Strengthening the role of clusters in innovation processes and development strategies Boosting dynamic development in key sectors and emerging technology-based clusters Harnessing the potential offered by social capital and innovation based on shared knowledge and relationships of trust among SMEs, industry leaders, the public sector and universities Internationalisation Cross-sectoral clustering
Netherlands, TopSector programme	<ul style="list-style-type: none"> Maintain the competitiveness of the Netherlands and to keep its international top position. The policy framework allows authorities to coordinate and steer compa- 	The top sector funding can include: <ul style="list-style-type: none"> tax benefits, innovation credits, grants, other. 	9 top sectors selected	Open innovation, Internationalisation

⁷¹ The Leading Edge Cluster Competition in Germany. Available at: <https://www.research-in-germany.org/en/research-landscape/research-organisations/networks-and-clusters/the-leading-edge-cluster-competition.html>

⁷² Ministry of Industry and Trade of the Czech Republic. Available at: <https://www.mpo.cz/en/>

⁷³ National Cluster Association of the Czech Republic. Available at: <http://www.nca.cz/en/nca>

Cluster programme	Rationale/Objectives	Form of support	Number of clusters	Most recent priorities
	nies, universities, and research centres through funding that encourage cooperation.			
Portugal, Competitiveness Clusters ⁷⁴	<ul style="list-style-type: none"> Support cluster policy, now strategically oriented for the consolidation or creation of competitiveness clusters Mobilisation of economic actors for collaborative knowledge sharing 	Support to innovation networks as cluster organisations that offer services to member companies such as: <ul style="list-style-type: none"> Funding Technical assistance in form of provision of training and consultancy services Initiating specific development projects Support to internationalisation Cross-clustering activities Cluster management excellence 	About 20 clusters identified by IAPMEI	Increase competitiveness Internationalisation Supporting cross-sectoral clustering
Regional				
Catalan Cluster Programme ⁷⁵	<ul style="list-style-type: none"> Systematise the action of the Catalan government in the field of cluster policy Contribute to rationalise the map of existing cluster organisations 	Support to innovation networks as cluster organisations that offer services to member companies such as: <ul style="list-style-type: none"> Technical assistance in form of provision of training and consultancy services Cluster labelling according to ECEI Support to internationalisation 	30	Boost the competitiveness of the Catalan economy, Systematise the actions of the Government of Catalonia in the field of cluster policy Streamline the clusters' map in Catalonia.
Basque Cluster Policy ⁷⁶	<ul style="list-style-type: none"> Promotion of greater added value activities to revitalise economic growth and job creation 	Support to cluster framework policies enhanced by: <ul style="list-style-type: none"> Funding Support to internationalisation 	20	Inclusion of new enabling technologies into the productive processes and final products; EICTs, BIO, NANO, Sustainable energy and green economy.

⁷⁴ Portuguese Agency for Competitiveness and Innovation, I.P. Available at: <https://www.iapmei.pt/>

⁷⁵ Catalan Cluster Programme. Available at: <http://accio.gencat.cat/cat/estrategia-empresarial/clusters/inici.jsp>

⁷⁶ Competitive transformation of Basque industries. Available at: <http://www.euskadi.eus/plan-pcti-2020/web01-a2lehiar/es/>

Cluster programme	Rationale/Objectives	Form of support	Number of clusters	Most recent priorities
				<p>Development of new business models and access to new areas of intercluster opportunities combining existing capabilities and converging technologies.</p> <p>Continue aligning cluster actions with the Smart Specialisation strategy.</p> <p>Internationalisation</p>
Walloon clusters:s, Competitiveness Clusters ⁷⁷	<ul style="list-style-type: none"> ▪ Increase members' visibility ▪ Help partnerships and collaborations between the members of the clusters 	<p>Support to cluster framework policies enhanced by:</p> <ul style="list-style-type: none"> ▪ Funding ▪ Support to internationalisation ▪ Conferences, seminars ▪ Technical assistance in form of provision of training and consultancy services ▪ Networking and partnering 	12	<p>Integration into global value chains</p> <p>Cross-sectoral linkages</p>
Scotland ⁷⁸ , support to key growth sectors	<ul style="list-style-type: none"> ▪ Supporting economic growth in Food and Drink, Financial and Business Services, Life Sciences, Energy, Tourism and Creative Industries ▪ Support in existing industries and within them emerging new activities 	<p>The support is not given to cluster organisations as such but to activities that support clustering and the development of selected key sectors and industries. Funding</p> <ul style="list-style-type: none"> ▪ Technical assistance in form of provision of training and consultancy services ▪ Support to internationalisation 	12 key sectors	<p>Cross-sectoral linkages</p> <p>Integration into global value chains</p> <p>Supporting diversification</p>
Lombardy ⁷⁹	<ul style="list-style-type: none"> ▪ Strengthening the role of the cluster as facilitator to boost the competitiveness of Lombard companies 	<p>Support to innovation networks as cluster organisations that offer services to member companies such as:</p> <ul style="list-style-type: none"> ▪ Funding 	Around 10 clusters	<p>Supporting new industrial value chains</p> <p>Supporting interregional value chains</p>

⁷⁷ Wallon Clusters: Competitive clusters. Available at: <http://clusters.wallonie.be/federateur-en/index.html?IDC=36>

⁷⁸ Scottish government. Available at: <http://www.gov.scot/Topics/Statistics/Browse/Business/Publications/GrowthSectors>

⁷⁹ Technologic Cluster Lombardy. Available at: http://www.s3.regione.lombardia.it/cs/Satellite?c=Page&childpagename=DG_Industria/MILayout&cid=1213792091374&p=1213792091374&pagename=DG_INDWrapper

Cluster programme	Rationale/Objectives	Form of support	Number of clusters	Most recent priorities
	<ul style="list-style-type: none"> Steady their role as intermediate governance also within the RIS3 implementation process 	<ul style="list-style-type: none"> Technical assistance in form of provision of training and consultancy services Initiating specific development projects Support to internationalisation Cross-clustering activities Cluster management excellence Cluster labelling according to ECEI 		

Appendix 2: International case studies

go-cluster

Programme rationale

The programme “go-cluster” is the successor programme of “Kompetenznetze Deutschland” (Networks of competence Germany) which was originally initiated by the German Ministry of Education and Research (BMBF) in 1999. In 2012, it was transferred to the Ministry of Economics and Energy (BMWi) and got the new name “go-cluster”. This led also to some adoptions of the funding scheme. Whilst Kompetenznetze Deutschland programme aimed at the generation of clusters, the go-cluster programme is more focussed on the proliferation of existing clusters. Following the new focus, go-cluster is aimed to combine the most powerful innovation clusters in Germany, to promote their further development by expanding the needs-orientated cluster structures and services for cluster management. Whereas the core aspects of Kompetenznetze were adopted in “go-cluster”, such as “Club of the best innovation networks”, “further development of cluster excellence”, “networking”, “increase of visibility through public relations and cooperation as well as events”, other aspects were additionally introduced:⁸⁰

- Support of the most powerful innovation clusters through demand-oriented consulting services and the introduction of the **quality criteria of European Cluster Excellence Initiative (ECEI)**⁸¹, with the silver label as a minimum quality standard
- Establishment and operation of the **cross-cluster platform Germany**, which is jointly supported by BMWi and the BMBF and aims to contribute to greater transparency in national and European cluster policy
- **Proportional grants for model projects** for the development and implementation of innovative services by cluster managements for their members (“go-cluster Services”) and cross-cluster collaborations

With the new design of the programme the provided service structure has been changed. Whilst in the Kompetenznetze programme there was an organising office (Geschäftsstelle), that mainly provided administrative services, in the new go-cluster programme that office was replaced by a pro-active service provider that is in charge to actively support cluster managements in their development. Furthermore, the selected service provider VDI/VDE-IT also delivers general information to the BMWi by observing and analysing national and international trends regarding clusters and cooperating with the federal states and federal cluster programmes.

The objectives of the “go-cluster” programme are: to further increase the quality of cluster management organisations towards international cluster excellence, to increase the international visibility of German cluster initiatives, and to support the German Federal Ministry of Economics and Energy in shaping its cluster policy as well as its activities regarding clusters on federal and EU level.

Essentially, the programme is pursuing the following five objectives:

- 1) **Increase of the reputation** of the clusters (clusters are entitled to carry the “go-cluster”-label)
- 2) **Professionalisation** of the cluster management by obligatory benchmarking and support in the development of cluster-management service concepts (clusters to meet ECEI standards).
- 3) **Higher national and international visibility** of clusters through events and presentation of clusters at the cluster platform (e.g. annual cluster conference).

⁸⁰ Evaluation des Programms go-cluster, 2016, Conabo; InterVal.

⁸¹ ECEI (European Cluster Excellence Initiative) is a benchmarking tool for cluster organisations to improve their internal management process and the way they offer services. The ICEI offers a uniform set of cluster management quality indicators and a quality labelling system with three levels (Bronze, Silver and Gold).

- 4) **More transparency** in publishing all relevant information on German clusters on one home page (all ministries collaborate on that platform).
- 5) **Stronger cross-linking of cluster-initiatives** (both nationally and internationally).

In addition, in the framework of the programme, the cluster platform Deutschland, the joint information portal of the BMWi and BMBF is implemented. Go-cluster is an “award-programme” with the ECEI-classification as guiding standards, meaning that the main activities are laying in the support of the clusters to reach higher levels of development. There is only limited financial support for the clusters which are part of the programme. The only direct support to the clusters is distributed through a competition on measures to enhance the quality of the management of clusters. Clusters can annually apply for cluster-specific projects and a total of €0,5m is allocated to the awarded projects. The competition is open for all clusters which have a ECEI-label and are not “in a critical observatory status”.

There was no major discussion regarding market failure prior to the implementation of the go-cluster programme. The main argument for the initiative was that the most powerful cluster initiatives should be integrated in a single measure to promote performance and competences in numerous strong sectors and technology fields within the German economy. Another explicit motivation for setting up the programme was the need to move from “learning by doing” in the direction of professionalising and recognise the “cluster managers” and establish horizontal learning between clusters.

Cluster policy in Germany is implemented on two levels. The federal states introduce new regional cluster initiatives, whereas the activities of the Federation target the stabilisation of existing structures and fosters an increased quality of clusters (e.g. in R&D projects or through stimulating internationalisation). Hence, **domestic clusters are the geographic range of the go-cluster programme**, addressing clusters in every federal state. However, only clusters which have reached a very high level of maturity are included in the go-cluster programme.

Go-cluster is part of joint activities of BMBF and BMWi which is labelled the “Cluster Platform”. In this joint action, BMBF is responsible for research based cluster policy whilst go-cluster (which lies under the responsibility of BMWi) aims mainly at the improvement of cluster organisation and management. While there, in theory, exists a clear division of labour between ministries, an evaluation in 2016 revealed that stakeholders perceive the go-cluster programme as not sufficiently cross-linked with programmes and initiatives governed by other institutions/ministries.

Key figures on the programme and key activities funded

There are no specific sectors targeted by the programme, but clusters are expected to be directed towards innovation. At present, 90 cluster entities are included in the programme, who collectively gather close to 15,000 active members. These include approximately 10,000 small and medium-sized enterprises, 2,000 large enterprises, more than 900 chairs and institutes at universities and 600 independent research institutes. The number of organisations per cluster vary from less than 20 to more than 200 members per cluster.

The clusters are classified in 35 different fields of technology, with most of them operating in areas as industry 4.0, automotive and production technologies. The financing of cluster management organisations is heterogeneous. Some are fully financed by the private sector, while others are financed mainly by grants from the respective federal state, in which the cluster management is based. The main sources of funding are membership fees, stakeholder contributions, paid services, sponsorship and public funding. The individual projects within the clusters have additional funding sources.

The main activities by the go-cluster programme are in the field of service provision and consultancy. Grants are only a small part of the overall programme. Hence, go-cluster is a programme which is focussing on technical support for cluster managements to further develop the most eminent clusters according to

international standards. For all activities, the ECEI-standards are the aspired benchmark. In more detail, the programme consists of the following services and activities:

- An ECEI quality and efficiency certificate for cluster management organisations applying uniform assessment criteria that comply with European quality standards
- Reimbursement of the costs of the Bronze or Silver Label of the ECEI
- The right to use the brand “go-cluster: Exzellent vernetzt!” as quality label
- Participation and higher visibility in government economic initiatives
- Increased national and international visibility to decision-makers representing government, business and administration
- Public presentations of cluster activities and selected success stories on innovation projects (events, newsletters, websites and clusters’ success stories “ClusterERFOLGE”)
- Networking activities with other innovation clusters from Germany and Europe
- Participation in seminars on topical matters of clusters and management, individual counselling of cluster managements on strategy development and entitlement to apply for funds

Cluster categories: rationale, relevance, effectiveness

As the programme is only targeting high-capacity clusters, which all have already achieved a high level of professionalisation, differences of maturity play only a minor role. However, one aim of go-cluster is to support clusters to reach higher levels in the benchmark framework of the ECEI. Consequently, after being accepted to the programme, clusters are obligated to participate in a benchmarking aligned with the quality criteria of the ECEI. Depending on the initial position, the clusters are then either required to achieve the silver or the gold label. Clusters possessing the latter, must retain their gold label.

Clusters are offered individual consulting equivalent to its status regarding the ECEI. To support clusters in their strive to develop and reach higher labels, go-cluster entails two different kinds of activities:

1. Individual support by experts from VDI/VDI-IT who offer site-visits and tailor-made consulting
2. Events that focus on exchange of experiences between clusters taking part in the programme. The meetings gather cluster managers from 4–6 clusters engaging in a topic with cross-sectoral and cross-technology relevance

Selection procedure and criteria

All innovation clusters are entitled to become part of the programme, granted that they comply with the admission criteria of the programme. Clusters can apply for admission at any time. In the first phase of the programme (2012–2015), a total of 48 applications were submitted and 25 applicants were approved and included in the programme. During this first phase, an assessment was made solely based on a written application. If 50 percent of the admission criteria were fulfilled, the BMWi was advised to include the applicant in the programme.

Since the second phase of the programme (from July 2015), the admission criteria have been extended and the entire admission process has been more formalised. In the application for admission, the cluster management is required to give inter alia information on the quality criteria (depicted in table 1). The quality criteria are oriented towards the ECEI-criteria. Further review of the clusters communication activities and publications are also part of the admission process. After an initial evaluation by the VDI/VDE-IT based on the application, an interview with representatives of the cluster management organisation is conducted.

Table 2 Admission criteria for go-cluster (minimum requirements)

Structure and composition	
Engagement of the stakeholders in the innovation cluster	At least 30 engaged cluster members
Composition of the cluster	At least 50% SMEs Sector-specific engagement of R&D facilities
Regional focus of the cluster members	At least 60% near 150km of the cluster management office
Cluster management and supervision	
Age and equipment of the management	At least three years in office since the formal foundation Appropriate number of people working in the cluster management
Integration of stakeholders in the cluster management	Appropriate representation of the different stakeholder in the supervision and decision processes
Existence of a cluster strategy and its implementation	Cluster stakeholders must be involved in the strategy process Strategy must be in the form of a written document Draft concept for revision must exist
Sustainability of financing	Contribution of the cluster members and the economic revenues must be at least 20% of the total budget of cluster management Provide proof of funding for at least 24 months
Activities and cooperation	
Activities and services	Spectrum and intensity of the services must be adapted to the needs and the strategy
Cooperation and internal communication	Existence of sustainable operational structures (e.g. organisation of working groups or cluster members) Development of internal communication structures
Visibility and Impact	
Unique selling points	Knowledge of the three most important competitors Identify the individual characteristics / special features of the clusters
External communication	Appropriate external communication and public relations
Visibility	Proof of visibility for external actors (frequency in the press / presentation on platforms / trade fair participation, etc.)
Previous effect of the cluster work	Presentation of three success stories during the last 24 months
Contribution to the ability to innovate	Anchoring in the regional innovation system Support for cluster actors in the innovation process Implementation of innovation projects

Source BMWi

The assessment after review of application and interview is summarised in an admission report and a recommendation is given to the BMWi and the accompanying advisory committee, but only if at least two thirds of the admission criteria are fully met. The advisory committee enrolls domestic and European experts on cluster policy. The members come from public institutions, universities and companies. In addition, to further secure the cluster-perspective, two cluster managers and two international representatives are part of the committee.

Since the second phase of the programme, ten applications have been submitted, of which two were positively evaluated and included in the programme. Since the implementation of the programme, however, some 20 cluster initiatives had also had to leave the programme, failing to meet the quality criteria.

Whereas for some criteria, it is relatively simple to determine whether they are fulfilled or not, for others, the assessment must be done with a more qualitative approach. For instance, “an appropriate number of people working in the cluster management” is assessed on a case-by-case basis. One interviewee stated that “if the cluster has 100 members but only allocates a 0.5 full-time position for the cluster management, it is doubtful that the cluster can respond to the needs of its members. On the other hand, if there are only 20 members but 3 full-time positions in the cluster-management, it might be an indication that the organisation is over bureaucratic”.

The cluster strategy is an important document used in the review process. The application process requires a cluster strategy which is valid at the date of the application and the information of the cluster strategy is used to assess whether the strategic activity fields are aligned with the services offered to the members. Another issue that is thoroughly assessed is the geographic anchoring of the cluster. The selected clusters are required to have a strong regional focus and a critical mass present at the location. Networks (containing organisations with little or no geographical proximity) are not relevant for the programme (this is a change to the original programme which also supported networks). The financing structure can give information on the commitment of its members: “the higher the private share, the more members are expected to be involved in the cluster’s activities because they are actively contributing” one interviewee says.

After a successful application and admission, it is mandatory for all clusters in the programme to participate in the benchmarking processes of the ECEI. To stay in the programme, the cluster management organisations must commit themselves to meet the quality criteria of the Silver Label of ECEI within two years. Clusters awarded with a ECEI-gold-label are included in the programme without further examination as the fulfilment of the admission criteria is confirmed by the possession of the label. Innovative clusters, which do not yet have an ECEI bronze label at the time of the programme entry, must make up for this as soon as possible after admission by means of appropriate benchmarking.

Monitoring system

The development and achievements of the clusters are monitored in the framework of the labelling-process for the ECEI. It is expected that the cluster achieves a higher label during its participation in go-cluster. Or, in case the gold label is already obtained, constant development is required to keep the label. Hence, the improvements of the clusters in different areas are monitored by the VDI/VDE-IT and then separately assessed.

Moreover, the VDI/VDE-IT is engaged in the development of the general cluster-monitoring for the BMWi in which structural data on the participating clusters are collected and presented before BMWi. Beyond that, the VDI/VDE-IT is collecting best practice examples from participating clusters at a monthly basis. The results of VDI/VDE-IT’s monitoring are discussed in the advisory board sessions and benchmarked against developments in other countries.

There are two ways in which the monitoring system fits the decision-making process for continuation of support. First, each cluster’s performance is reviewed every second year and if the cluster shows lack of progress in comparison to the previous assessment, VDI/VDE-IT will commence a more comprehensive review.

On the other hand, the performance development in the ECEI can lead to a more specific assessment by VDI/VDE-IT, namely if the silver label has not been achieved in the period foreseen. In the reassessment process, the cluster under consideration schedules a meeting with VDI/VDE-IT to commonly identify the reasons for the lack of development. Depending of the area in which the cluster needs to further develop, a plan and an according timeframe is set up in which the improvements must take place. The VDI/VDE-IT also regularly screens clusters where members don't make use of the services offered. In the quality assurance process, VDI/VDE-IT screens the internal data and compares them with other available data and if there is an accumulation of fields in which the cluster does not fulfil the quality criteria anymore, the head of the programme visits the cluster to have a validation dialogue. Following the meeting, the head of the programme writes a report with a clear recommendation to either continue to support the cluster or exclude it from the programme. The assessment and recommendation are forwarded to the ministry as well as the advisory board for further action. As consequence of this process, go-cluster last year excluded 13 clusters from the go-cluster programme. Either, the organisations failed to further develop their activities or voluntarily wished to no longer participate in the programme. An evaluation of 2016 revealed that since 2006, in total 91 clusters have been excluded from the programme for various reasons.

Programme evaluations are conducted with irregular intervals. The latest evaluation, published in the beginning of 2016, was an overall assessment of the go-cluster programme period 2012–2015, with the following mandate:

- The presentation and assessment of the objectives of the go-cluster programme and the cluster platform Germany, based on the services offered and their effects (ex-post evaluation). As a result of these steps, recommendations for the possible continuation and quality assurance of the programme
- Comparative assessment of the current conception of the programme with an external programme service provider, in contrast to the business concept in the predecessor initiative "Kompetenznetze Deutschland".
- Elaboration of criteria and procedures for future performance controls and future evaluations in relation to § 7 (2) of the Bundeshaushaltsordnung (BHO)⁸²

The methodological framework of the evaluation was an ex-post evaluation combining quantitative and qualitative methods. *Table 3* depicts a sample of the indicators used in the evaluation, classified under the different modules of the programme. The results of the evaluation are described in further detail below.

⁸² Bundeshaushaltsordnung (Economic regulation of the federal state) §7 aims at the evaluation on an adequate use of tax money in the programme.

Table 3 Examples of output and outcome indicators used in the evaluation of the go-cluster programme (2016).

Evaluation modules	Output-indicators	Outcome indicators
National and international cross-linking	Number and type of activities initiated by VDI/VDE-IT, which aim to gear go-cluster activities with regional, national and international events	Objective fulfilment of cross-clustering projects Effects of participation in programme (perceived increased attractiveness of the cluster after participation in the programme, benefits for members etc.)
Composition of the cluster	Share of new content on the website Number and kind of newsletters sent	Development of numbers of visitors of the homepage classified by actor type and geographical location
Excellence impulses for national innovation cluster	Type and number of events for information and professionalisation of cluster managers, individual support services	Demand for and participation of the clusters in the activities Reasons for participation and non-participation Experienced benefits of the benchmarking process Clusters' intentions to apply for silver/ gold labels (or not)
Grant support (competitive projects)	Subsidy amount per project Thematic area of the subsidised projects	Number of submitted project applications Number of cluster members involved in the projects Transferability of developed services (use of information channels, number of services adopted in other cluster initiatives etc.)

Sustainability of clusters

There is no predetermined period of support to the cluster included in go-cluster. As described above, only a small part of the support services are delivered in form of grants. Most return from the programme consist of the ECEI assessments, learning activities, consultancy services, increased visibility and positive reputation that follows being labelled as a “go-cluster: Exzellent vernetzt!”. In cases where grants are given to clusters a clear time framework is established. There is an annual call for competitive grants where “go cluster” organisations are eligible to apply. The grants are bound for small projects with a clear duration and objective. The aim of the support is not to sustain clusters financially but rather function as complementary funding for specific development projects. Consequently, there is no transition process needed for clusters exiting the go-cluster umbrella, and clusters are in general able to “live on” following the exit of go-cluster. As explained above, the programme is only targeting mature clusters which have a high-competence profile and often have a sustainable business model prior of entering the programme.

Lessons learnt from the cluster programme

What lessons learnt from the go-cluster programme can be of relevance for the Norwegian Cluster Programme? On the one hand, some activities of the two programmes seem to be almost identical (such as expert services and links to the ECEI standards). On the other hand, the Norwegian Innovation Cluster programme integrates also financial support, which play only a minor role in the go-cluster programme. In Germany, this financial support – especially to “targeted and time-limited development projects” is mainly offered in other programmes – either at the federal level or in programmes which are dedicated to specific thematic topics (e.g. internationalisation, R&D cooperation, cooperation between SMEs etc.). Go-cluster is a “reward-programme” with a strong focus on increasing reputation and visibility of the cluster and fostering the professionalisation of cluster management. It is hence only partly overlapping with the NIC programme. These following performance goals, are partly shared by both programmes:

<i>Norwegian Innovation Cluster programme</i>	<i>go-cluster</i>
International focus	Higher national and international visibility
Attractiveness and profile	Increase of the reputation of the clusters Professionalisation of the cluster management
Cooperation and collaboration	Stronger cross-linking of cluster-initiatives (domestic and international)

Higher national and **international visibility** of the clusters in “go-cluster” is *inter alia* aimed to be reached through events and presentation of clusters at the website “Cluster Platform Deutschland”. The interviewed stakeholders of the go-cluster programme generally assess the established cluster platform to be effective. Moreover, they claim that the platform can assist in delivering information about other clusters and hence, facilitate cooperation. User statistics show that the visibility of the website is significant, both in terms of domestic and foreign users. The homepage of the Norwegian Innovation Clusters is only partly in English, e.g. an overview on all available clusters is missing. Apart from facilitating the cooperation and knowledge between the clusters, international visibility could be increased, and the international focus strengthened.

In contrast to the NIC programme, the aspect **networking** of “go-cluster” is exclusively referring to external contacts (and not within the cluster) by fostering a stronger cross-linking of cluster initiatives. Nearly half of the surveyed cluster managers see positive networking effects through new contacts with other cluster initiatives (through conferences, network activities etc.). But also, the fostering of “cross-clustering”-projects helped several clusters to establish sustainable cooperation with other German clusters. In the evaluation, it was however recommended to provide access to some of the programme activities for external (also international) participants, to avoid lock-in-effects and to increase the visibility of the programme.

The label “go-cluster” was established as an additional quality label for the clusters to increase the **reputation among sponsors, stakeholders and decision makers**. The evaluation revealed that the go-cluster programme has positive reputation effects for the clusters but only to a limited degree. Moreover, participants assessed the benefits to be higher in terms of outreach to the political sphere, than to other sectors. Effects of visibility were identified sporadically, however most of the effects on visibility were mainly linked to the ECEI label, rather than an effect of being part of the go-cluster programme.

Clusters with the ECEI gold label expressed a higher benefit of reputation than those attaining a silver label. To increase the reputation and visibility of the programme, the evaluators recommended to strengthen the interaction and cooperation with other national cluster programmes, to push for more publications in English, and to use the label “go-cluster” more prominent on the cluster websites. The overall conclusion is that focussing on the ECEI-criteria as quality label might be sufficient, and the establishment of a further quality label can be proven to be ineffective.

Regarding the ECEI-criteria as reference point for the go-cluster benchmarking, the evaluators recommended that these criteria should be reviewed and complemented, as some stakeholders criticised that the ECEI-criteria are too generic to correctly depict the development of the heterogeneous set of clusters included in the go-cluster programme. The evaluation also suggested that the assessment criteria could not determine to what extent the cluster management development provided benefits to the members of the clusters. It was hence suggested to add more “dynamic criteria” to the benchmarking to draw conclusions regarding the benefits for the members, such as growth of the member base, development of R&D intensity and self-financing.

With regards to the objective **professionalisation of cluster management**, the evaluation revealed that the technical know-how of the cluster managers in general increased after participation, and the evaluation specifically identified the customised consultancy services as effective.

The evaluation of the go-cluster programme also entailed a short **profitability analysis** which denoted the activities to be overall cost-efficient. The total costs of the programme (€3.3m for a three-year period) was divided by the average number of cluster members (14,439) for all 100 clusters which benefited from the initiative. This led to the average cost of €228 per cluster member for a period of three years, and an annual cost of €80 per member. Adding the overall positive assessment of the programme, this cost was seen as justified according to the evaluation.

There is a continuous discussion on the implementation of the admission criteria and how to assess the performance of the clusters in the advisory committee. The linkage to the ECEI-criteria was one of the adoptions made after reviewing the overall concept of the programme. The open dialogue between the committee and representatives of the Ministry is seen as major advantage by one of the interviewees as it has made the whole process more transparent and effective.

Sources

Referenced documents

Conabo; InterVal (2016) „Evaluation des Programms go-cluster“, Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie (BMWi), <https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/evaluation-des-programms-go-cluster-studie-im-auftrag-des-bmwi.html>

List of interviewees

Claudia Buhl, VDI/VDE IT, Project manager of “go cluster”

Axel Bauer, Fraunhofer-Institut für Lasertechnik ILT, member of the accompanying advisory committee

Innovation Networks Denmark

Programme rationale

Clusters and innovation networks are an important part of the work conducted by the Danish Government and the regions to strengthen growth, innovation and research collaboration of companies. A *cluster* is defined in the Danish context as a group of enterprises that have teamed up with research and educational institutions and other actors because collaboration offers competitive advantages that an individual enterprise cannot achieve on its own. The *innovation networks* have the additional task of building bridges between knowledge institutions and businesses within areas where Denmark has strong competences and growth opportunities. The cooperation must be based on a clearly defined professional or technological focus area, as defined by the innovation network itself. This might, for example, be a particular technology, a key business strength, a problem relating to a defined business area, or a sector, cluster, business segment, or similar.

The national Danish cluster programme Innovation Network Denmark (Innovationsnetværk) was launched in 2013 and is a permanent building block in the national research and innovation system. The initiative was the first nationwide strategy for supporting clusters and innovation networks, involving central actors such as the Ministry of Higher Education and Science, all Danish regions and the association and interest organisation of the 98 Danish municipalities, LGDK (Local Government Denmark).

The Ministry of Higher Education and Science (Uddannelses- og Forskningsministeriet) oversees the innovation network and supports the establishment of network and cluster organisations on a national level. An innovation network has participation of all relevant Danish universities and technology institutes within a specific technological area, a business sector or a cross-disciplinary theme. Each network has pools for innovation projects where firms and researchers work together to solve concrete challenges. The innovation networks also carry out idea generation processes and matchmaking activities, and they hold theme meetings and specialist events.

Prior to the Innovation Network programme, clusters and innovation networks were one of many focus areas in the Danish research and innovation policy. The principal rationale for focusing on clusters and innovation networks was to create platforms for matchmaking, knowledge transfer and collaboration between research institutions and private companies. With the 2013 initiative, the Innovation Networks programme was defined as a key instrument for achieving the government's objectives:

- Danish companies and public institutions to be among the most innovative in the world
- Denmark to be among the countries that are best at converting research results into new technologies and processes
- The private sector's research and development activities must be increased

The cluster strategy has evolved over time and was last updated in 2016.⁸³ The updated strategy holds new ambitions and objectives for the continuing efforts of supporting clusters and innovation networks. The overall objective of the Innovation Networks initiative, as defined by the updated strategy, is (1) to strengthen public-private collaboration and knowledge transfer between public universities and private companies on research and innovation; and (2) to strengthen innovation and research in Danish companies and thus promote knowledge-based growth in business and industry.

The programme aims to overcome organisational, cultural, and operational barriers regarding knowledge transfer and collaboration between businesses and knowledge institutions. Furthermore, the Innovation

⁸³ Klyngestrategi 2.0 – Strategi for Danmarks klynge- og netværksindsats 2016–2018, 2016, Ministry of Higher Education and Science.

Network programme aims to manage the tendency of SMEs to under-invest in R&D activities in relation to the potential gains for the companies and society at large.

Innovation Networks are national and nationwide. This does not exclude the innovation networks from playing a role in regional development, although this will typically require the networks to receive separate funding for this purpose, for example from the regional growth forums. Denmark has more than 50 clusters and innovative networks who aim to create growth and innovation nationally or regionally.

Denmark has set up a national support function for clusters and innovative networks through the Cluster Forum (Klyngeforum), Cluster Excellence Denmark. It provides a number of services for the clusters and innovative networks in order to ensure optimum working conditions. The initiative is co-funded by the Danish Agency for Institutions and Educational Grants and the regions. The Ministry of Higher Education and Science administrates the Cluster Forum and other participants are the Ministry of Foreign Affairs, the Ministry of Business and Growth, the Ministry of Environment and Food, the Ministry of Energy, Utilities and Climate, The Ministry of Health, all six regional growth forums, Danish regions, Local Government Denmark (LGDK), as well as Copenhagen, Aarhus and Aalborg municipalities. The Cluster Forum was established in 2013 with the aim of supporting cluster development in Denmark and creating cohesion between local, regional, national, and international cluster and network efforts.

Key figures on the programme and key activities funded

It is up to each innovation network to define the exact target group for its activities, however the defined target group must have critical mass in terms of the number of companies. The primary target groups for the innovation networks in general are companies within the network's focus area, especially SMEs, and research and knowledge institutions and technological intermediaries that operate within the network's focus area. There are currently **22 innovation networks** included in the programme, distributed on nine different sectors, listed in *Table 4*.

Table 4 List of networks currently included in the programme.

Sector (number of networks)	Networks (granted public funding in mDKK)
Production, new materials, and design (5)	Innovation Cluster for Production (14) Lifestyle & Design Cluster (14) Innovation Network RoboCluster (14) Danish Material Network (14) Danish Lighting Innovation Network (12)
Service (4)	Service Cluster Denmark (14) Innovation Network for knowledge-based experience economy (12) Innovation Network for Market, Communication and Consumption – BRAND-BASE (12) Innovation Network for Finance IT (10)
Health (3)	Innovation Network for Biotech – Biopeople (12) Innovation Network for Health and Welfare Technology – Welfare Tech (12) Innovation network for Biomedical Engineering – MedTech Innovation (12)
Energy (3)	Offshoreenergy.dk (14) Innovation Network for Biomass – INBIOM (14) Innovation Network for Smart Energy – Inno-SE (14)

Environment (2)	Innovation Network for Environmental Technology – Inno-MT (14) Innovation Network Water in Urban Areas (12)
ICT (2)	The Danish ICT Innovation Network – InfinIT (14) Danish Sound Innovation Network – Danish Sound (12)
Food (1)	Innovation Network for the Food Sector – FoodNetwork (14)
Construction (1)	Innovation Network for Energy efficient and Sustainable construction – InnoBYG (14)
Transportation (1)	The Transport Innovation Network –TINV (14)

Source: Bevillingsoversigt over godkendte innovationsnetværk 2014–2018, Ministry of Higher Education and Science.

Funding of innovation networks consist of three parts: governmental support, private self-financing and other co-funding. The governmental co-funding may account for a maximum of 50 percent of the costs for the activities of each innovation network, described in *Table 5*. This share of the networks funding may be used primarily to cover the costs of the participating knowledge institutions that work on disseminating knowledge and technology, and to a lesser extent on other expenses. The total allocation of governmental co-funding for the 22 networks during the period of 2014–2018 amount to DKK278m.

Table 5 Activities of innovation networks that is publicly co-financed.

Pillars	Activities
The operation of a network secretariat	Preparation of strategies, analyses and reports within the network's focus area Financial management PR work
Matchmaking and knowledge dissemination activities	Assist companies and researchers to find concrete cooperation partners Conferences, seminars, experience-exchange groups, etc. Communication activities Development of new courses of education or technological services
Development projects	Related to the innovation network's professional focus area Development of new knowledge, and dissemination and utilisation of the knowledge of research and knowledge institutions, based on the companies' concrete requirements
Internationalisation	Collaboration with foreign clusters and knowledge institutions

Source: Guidelines for the Danish Ministry of Science, Technology and Innovation's "Innovation Networks Denmark" programme, 2009, Ministry of Higher Education and Science.

Private funding (which at least must cover the costs of participating companies) is required to amount to a minimum of 80 percent of the state funding. This is often done in form of in-kind contributions where companies are incentivised to participate in the network's activities and account the time spent as part of their co-funding. Other co-funding includes financing from regions, municipalities, other public institutions, EU programmes, participating knowledge institutions, etc.

The size of the clusters and innovation networks in Denmark varies considerably. The largest cluster involves close to 400 companies and the smallest around 20 companies. But the benefits of the networks should not be exclusive to the participating members. Knowledge dissemination and matchmaking activities are open for any company to participate in and the collaborative projects supported by the networks are required to ensure a broad dissemination of results.

Cluster categories: rationale, relevance, effectiveness

The innovation networks may receive funding for up to four years at a time. After the first two years the Council for Technology and Innovation will assess whether the network has lived up to the agreed goals, milestones, and other criteria for the success of the network. After four years it will be possible to apply for the continuation of the innovation network, but this will be in competition with the other innovation networks, as well as applications to establish completely new networks.

Companies are encouraged to take active part in the activities offered by the networks. The fundamental idea is that participating companies gradually is stepping upwards on the “knowledge ladder” as they increase their R&D intensity and knowledge; and networks. Clusters comprise of companies that ranges from inexperienced actors with low degree of innovation capacity to advanced actors with a very high degree of innovation capacity and knowledge intensity within the organisation. By establishing platforms for companies with different levels of R&D maturity, the networks become arenas for efficient exchange of knowledge and experiences related to issues of relevance for companies within common sectors.

The innovation networks are categorised in accordance with the The European Cluster Excellence Initiatives labelling system, which presents three levels for quality achievement: Bronze, Silver and Gold. Denmark's innovation networks are required to reach at least the Bronze Label, with ambition and opportunity to reach and sustain a Gold Label or at the very least Silver Label.

Consequently, the categorisation of the innovation networks is not done within the Innovation Network programme. All clusters in Denmark are labelled within the framework of ECEI, coordinated by Cluster Excellence Denmark. The labelling of clusters is motivated by the objectives in the Strategy for Clusters and Networks, to increase the professionalisation of Danish clusters and innovation networks, giving them a greater ability to create growth, nationally and within relevant business sectors. All clusters, regardless of label obtained, are offered regular training to develop competence on all three levels, through the national support function of Cluster Excellence Denmark.

Selection procedure and criteria

When the Innovation Network programme was launched in 2013, the Ministry of Higher Education and Science received 28 applications from various cluster organisations around Denmark. Of these 28 applicants, 22 clusters met the criteria and were granted funding through the programme. The main criteria for being included in the Innovation Network programme in 2013 was the same as for the current phase of the programme, that is building bridges between knowledge institutions and businesses increasing collaboration in terms of research and innovation, and strengthen research and innovation activities in Danish businesses in order to develop knowledge based growth.

In order to be considered an innovation network, the clusters also have to contribute to the establishment of efficient matchmaking features, granting businesses across Denmark an easy way towards research and knowledge in a professional field, that goes beyond existing knowledge institutions. Furthermore, the networks should serve as a focal point for relevant stakeholders within the network's focus area. This also include providing members with relevant activities and services as well as national and international visibility. An innovation network should also be a factor in creating long-term collaborations between businesses, knowledge institutions and other relevant partners (e.g. in the public sector), in order to increase the use of research based knowledge and contribute to the solving of concrete challenges.

It is expected of an innovation network to work towards increasing corporate international orientation (especially among SMEs), grant companies access to internationally leading knowledge institutions, and promote international cooperation by facilitating participation in international research and knowledge clusters. Through the innovation networks the research of knowledge institutions should increasingly be addressed to the needs of the society. It is also the intention that the networks will increasingly serve as a turning point for consistency in research and innovation efforts in the network's area of expertise. This applies to other governmental efforts and project activities and in relation to relevant regional initiatives. Thus, it is expected that the networks remain informed about other important initiatives and projects, to keep the members of the network up-to-date of relevant results within relevant topics of the operating area.

For each innovation network, there is a set of criteria that have to be met in the selection process.⁸⁴ In short, the assessment of applications will give weight to the following criteria:

- The innovation network's rationale and professional focus
- Target company group
- The network's position in the innovation promotion system
- Partner structure
- Company participation – and support
- Organisation
- Useful effect of the concrete development projects
- Useful effect of matchmaking and knowledge dissemination activities
- Future activities
- Economy and co-funding

According to the interviewed representative at the Ministry of Higher Education and Science, all criteria rendered above are of equal importance in the selection process. However, there is a special focus on how the network can facilitate interaction between research institutions and the intended business target group (especially the SME collective). In 2014, a renewal of the innovation networks was implemented but the criteria in the main proceedings in the selection process were left unchanged.

Monitoring system: effectiveness of the monitoring system and efficiency

To monitor the progress on implementation and achievements of clusters, Denmark has established a centralised feedback system. This means that the innovation networks are responsible for reporting their progress to the Ministry of Higher Education and Science on a regular basis. Among other things, the feedback system requires the innovation networks to develop an annual action plan. The guidelines for reporting are briefly specified in *Table 6*.

More specific requirements for the action plan is that it should be divided into various sections, namely "General activities", "Action plan for academic themes" and "Major development projects". The plan for the general activities should include for instance management of the network, establishment of new collaborations, matchmaking activities and communication. The other activities of the network are divided into a number of appropriate and coherent academic themes or areas of activity. Each field of activity must have its own action plan that gathers the smaller activities planned within this theme. Individual activities and

⁸⁴ Guidelines for Innovation Networks (Retningslinjer for innovationsnetværk), Ministry of Higher Education and Science.

development projects in which a deduction of more than DKK 200,000 of the annual network grant is expected to be described in a separate action plan.

Table 6 Overview of innovation network reporting requirements

Deliverables	Frequency	Delivery time
Action plan and budget for the entire year	Annually	No later than 2 weeks before the end of the current action plan
Interim report and financial statement	Every six months	No later than 3 months after the end of the six months
Annual report and financial statement – including status	Annually	No later than 3 months after the end of the fiscal year
Accountant's statement / statement from the financial controller	Annually	No later than 3 months after the end of the fiscal year
Mid-term evaluation	After 2 years	2-2,5 years into the 4-year period
Final report	After 4 years	No later than 3 months after the end of the 4-year period

Source: Vejledning til udarbejdelse af årlige handlingsplaner og budgetter samt afrapportering af innovationsnetværk, Ministry of Higher Education and Science.

At programme level, the Cluster Forum is responsible for monitoring, evaluating and measuring the impact of the cluster policy, partly by means of an annual set of performance indicators that shows the overall progress of the networks. To ensure the same high standard of impact assessments, the Ministry of Higher Education and Science commissioned the Central Innovation Manual on Excellent Econometric Evaluation of the Impact of Interventions on R&D and Innovation in Business (CIM). And is a general-purpose tool for assessing and evaluating the implementation of innovation policy instruments. The Manual was updated in 2014 (CIM 2.0) and states the minimum standards and requirements for the implementation of excellent econometric impact analyses.

The Innovation Network programme was subject to an impact analysis in 2011.⁸⁵ The programme was also part of a short-term impact assessment in 2014.⁸⁶ The short-term impact assessment uses various estimation methods for quantifying productivity growth and analyses of differences between participating companies and non-participants, with the strive to isolate the impact of the instrument in relation to external factors. This was done by first constructing a control group of non-participating companies, with similar traits to the participants. Through this method it is possible to argue that the identified effects can be attributed to participation in the instrument. Secondly certain assumptions are made to conclude that the found effects are significant. The impact study from 2011 used a similar matching-approach, in accordance with the CIM standard for impact assessments. This study was carried out from two different perspectives:

1. A general perspective that attempts to identify the overall participation effect by using the full sample of participating companies in innovation networks, disregarding the variation in participation type
2. A perspective that subdivides participation according to participation type and conducts the impact analysis for each type separately

⁸⁵ The impacts of cluster policy in Denmark - An impact study on behaviour and economical effects of Innovation Network Denmark, 2011, The Danish Agency for Science, Technology and Innovation.

⁸⁶ The Short-run Impact on Total Factor Productivity Growth of the Danish Innovation and Research Support System, 2014, The Danish Agency for Science, Technology and Innovation.

There are a number of quantitative indicators put in place for the Danish cluster policy to monitor the development to the objectives set for 2016–2018 strategy. The first one states that at least 2,000 companies annually have developed new innovations as a result of the cluster activities. The status in 2014 was that 1,600 enterprises had reached this goal. Another indicator is that there is an appropriate regional distribution of the companies that have developed new innovations, reflecting that the policy benefits the whole of Denmark. Furthermore, at least 2,500 enterprises participate annually in partnership projects with knowledge institutions through clusters. The follow-up of this indicator in 2014 showed that 1,800 companies had participated in such partnership projects through clusters. The cluster policy for 2018 also states the indicator that at least 1,500 companies participate annually in international activities through clusters. The status of such participation in 2014 was 900 companies. The last indicator is that Denmark has at least 10 Gold and 10 Silver clusters in 2018, certified by the European Cluster Excellence Initiative.

Sustainability of clusters

The Innovation Network programme operates with calls for tenders in conjunction with the programme phases that run for four years, hence the grant is predetermined for a four-year period but the innovation networks have every opportunity to apply for continued support from the programme for future programme periods, however in competition with others. In the call for tenders in 2014 most of the established innovations networks remained and a handful of new networks were granted support. The interviewed official at the responsible Ministry points out that the financial support to innovation networks is not to be considered as base funding, but rather as a project grant for the networks' specified activities. For the next call, the Ministry has the ambition to consolidate and decrease the number of networks and increase the critical mass among the networks' secretariats.

Considering that the financial support of the programme is intended to function as top-up funding for specific activities, the aim of the measure is not to sustain the networks financially. Consequently, there is no transition process in place for the networks that will exit the Innovation Network programme after the end of this funding period, given the ambition to scale down the number of networks. Since the programme targets networks that at least has obtained the Bronze level qualification of the ECEI, they are assumed to have a sustainable business model even prior of entering the programme. This means that innovation networks exiting is likely to continue, even without the financial support from the government.

Lessons learnt from the cluster programme that could be of relevance for Norway

The impact assessments of the Innovation Network programme reach the same conclusion, that companies participating in the programme tend to grow faster than non-participants. The aforementioned short-term impact analysis shows that companies participating in innovation networks achieve a growth and productivity that is 3.6 percent higher than those who do not participate. The impact study from 2011 shows similar results:

- Participation increases the probability to innovate by more than 4.5 times year 1 after participation
- Participation increases the probability of R&D collaboration by 4 times year 1 after participation

Furthermore, the study shows that effects of companies taking part in the Innovation Network programme varies depending on the prior experience of the innovation system. Hence, companies without prior involvement in the innovation system will experience more profound results in the short-run than companies with a higher degree of experience in terms of innovation and R&D activities. The share of companies participating in the programme that is considered to be innovative is also significantly higher than in the non-participants group, depicted in *Table 7*.

Table 7 Impact on innovativeness on participants in Innovation Networks.

Status	Share of innovative companies 2004	Share of innovative companies 2007
Participating companies in innovation networks	51.2%	73.1%
Non-participants	42.0%	42.8%

Source: The impacts of cluster policy in Denmark - An impact study on behaviour and economical effects of Innovation Network Denmark (2011).

This does not only show that companies participating in innovation networks are more innovative than Danish companies in general, but also that the share of companies being innovative is much more likely to grow if they participate in innovation networks. The share of companies performing R&D activities is also significantly higher among companies participating in innovation networks compared to the control group. Out of 641 participating companies investigated, 438 carried out R&D activities. That corresponds to 68.3 percent, compared to only 35.8 percent in the control group.

The Innovation Network programme has been proven successful in promoting small or medium-sized companies their innovation capacity. This is shown by the fact that 58 percent of the companies participating in the innovation networks have less than 20 employees, while only 11.3 percent have more than 250 employees.

Sources

Referenced documents

- Guidelines for the Danish Ministry of Science, Technology and Innovation's "Innovation Networks Denmark" programme
- Retningslinjer for innovationsnetværk
- Analysis of the Danish Research and Innovation System – A compendium of excellent systemic and econometric impact assessments
- The impacts of cluster policy in Denmark - An impact study on behaviour and economical effects of Innovation Network Denmark
- Vejledning til udarbejdelse af årlige handlingsplaner og budgetter samt afrapportering af innovationsnetværk

List of interviewees

- David Grønbæk, Head of Section Innovation Networks

Pôles de compétitivité

Programme rationale

The French cluster policy (“politique des pôles de compétitivité”) was launched in 2004, with an overall objective of improving the competitiveness of the French economy through innovation. Competitiveness clusters (“pôles de compétitivité”) were established, to foster innovation and contribute to economic growth and employment, notably on flourishing markets. The policy was notably designed in reaction to a report prepared for the Prime Minister, advocating to support ecosystems of growth and competitiveness and to create competitiveness clusters (Blanc 2004). The report labelled existing national innovation systems as “top-heavy and vertical”. They were pointed as fossilised systems that were fit for the 30-year post war booming period, but had not evolved to adapt to the current needs. This situation was assessed to impede interactions between research, education and companies, from which innovation and competitiveness take birth. The report also underlined the importance of further devolution, with the involvement of the regional authorities, and the strengthening and concentration of universities to support innovation and competitive business sectors.

A competitiveness cluster is defined as a catalyst of innovation **on a defined territory and on a specific theme**, mobilising companies, both SMEs and groups, Public Research Organisations and Higher Education Institutes on shared development strategies and collaborative projects. It aims at giving partner firms the chance to become first in their markets, both in France and abroad.

In the early 2000s, traditional State interventions on support to industrial policies through innovation were mostly done via national and sectoral policies building research programmes on to large companies and large research organisations. This model started to evolve during the 1980s due to globalisation, European integration and decentralisation. Unlike this traditional model at that time, the cluster policy aimed at creating or developing existing local specialised innovation ecosystems, stimulating cooperation links between different types of stakeholders and supporting collaborative innovation projects. For some of the clusters, the policy strived at creating global players with an international visibility.

Overall, the implementation of the policy aimed at increasing the effort of innovation of companies, while strengthening activities, mostly industrial, with a high-value content and to improve French attractiveness through a reinforcement of its international visibility. This was also the first time that an innovation policy had a territorial planning component.

In 2009, another programme on business clusters (“grappe d’entreprises”) was launched by the inter-ministerial delegation for territory planning and regional attractiveness, DATAR (then CGET). These business clusters gather SMEs specialised in a sector, with an objective of animating territorial industry in order to contribute to commercial development, and all sort of innovations development. In comparison to competitiveness clusters, it notably focuses on actions closer to the market (and less on technological or R&D aspects) and in territories where the critical mass is insufficient to support the creation of a competitiveness cluster. The DATAR/CGET aims at ensuring complementarity and collaboration between business clusters and competitiveness clusters. The 2015 evaluation of the business cluster policy noted that the technological positioning of business clusters (concentrating on low to medium-low sectors) is complementary to the positioning of competitiveness clusters, although the territorial complementarity is heterogeneous. As the scope of the missions asked to the competitiveness clusters broaden over time, there might however be some overlapping in the services offered by the two kinds of stakeholders. From an external point of view, the report notes that there is a risk of a ranking between these categories of clusters, in relation to the amount of State money provided to each policy, which is more important for the competitiveness cluster.

In addition, some initiatives appeared at the regional level. For instance, in 2006, the region Provence Alpes Côte d’Azur decided the creation of the PRIDES (“Pôles Régionaux d’Innovation et de Développement Economique Solidaire”) to complete the national policy by offering a better geographical and thematic

meshing of the regional territory. Some of these PRIDES are also competitiveness clusters (10 out of 29). Similarly, the region Nord-Pas de Calais created 12 “pôles d’excellence régionaux” in 2010 with the objective of structuring priority sectors in the region.

The competitiveness cluster policy has evolved over time. Currently, the policy is within its third phase:

- The objectives of the **first phase** (2005-2008) were as following:
 - Concretise partnerships between different complementary stakeholders
 - Support the emergence of strategic collaborative R&D projects that could benefit from public aids, including the only interministerial fund “Fonds Unique Interministériel (FUI)”
 - Promote a global environment in favour of innovation and of the clusters’ members through animation, resources pooling and members support on private funding, international development, intellectual property and human resources management
- The objectives of the **second phase** (2009-2012) were as following:
 - Reinforce the animation and the strategical steering of the cluster, notably through the implementation of “performance contracts” and the reinforcement of the State correspondents
 - Develop structuring projects, notably innovation platforms
 - Support even more the development of the growth and innovation ecosystems of the companies, by using more private funding and searching better territorial synergies
- The objectives of the **third phase** (2013-2018) were as following:
 - Transform the clusters from a “project plant” to a “products for the future plant”, in order to support project holders in placing their innovative solutions on the market
 - Reinforce the support for the development of SME and medium-sized groups (access to funding, international development, training needs etc.)

Clusters’ activities were developed and implemented over time to adapt to the evolution of these objectives, with a current trend towards the development of supporting services for the development and SMEs, and not only geographical and sector animation and emergence of R&D projects as it was the case at the inception of the policy.

Until the second phase, the policy was mostly steered by national administrations. Over time and given the ongoing devolution process⁸⁷, regional authorities have been further implicated in the policy steering. In order to enhance the effectiveness of the public action, regional authorities are represented within the two national steering bodies:

- The steering committee, the operational body for the management of the cluster policy
- The technical committee, its technical adaptation

In these two bodies, regional authorities are represented by the Association of French Regions, but also by representatives of some regions (Île-de-France, Auvergne-Rhône-Alpes, Occitanie, Hauts de France). There is no uniformity of the region speech.

DATAR/CGET is the national administration in charge of animating the competitiveness cluster policy alongside the General Directorate for Companies (DGCIS, former DGE) from the Ministry of Economy.

⁸⁷ Promulgated in 2015, the law on the new territorial organisation of the Republic “loi portant sur la Nouvelle Organisation Territoriale de la République (NOTRe)”, gave new competencies to the regions (notably in terms of economic development) and redefined the competences linked to each link of the territorial authorities.

Besides CGET and DGE, other State administrations or entities represented in the steering committees include the Ministries of Research, Agriculture, Defence, Health and Transport, the national agency for research and public financial entities (Caisse des Dépôts et Consignations and Bpifrance).

Further to these two steering committees, a national orientation committee provides recommendations on the competitiveness cluster policy. This consultative body counts institutional stakeholders (ministries, local authorities, public entities), qualified personalities and clusters' representatives. At the local level, coordination committees exist, under the mutual presidency of the regional prefect (representative of the State) and the president of the regional council. They allow for regular exchanges between public authorities and clusters, on themes such as strategy, projects progression, funding...

An association, "Association française des pôles de compétitivité (AFPC)", was created in 2013. It aims at federating French competitiveness clusters by developing innovation ecosystems and representing its members in front of national and European authorities. It is an offshoot of a previous association uniting the biggest clusters, under the categories "global" and "global vocation". Although its members represent the majority of the competitiveness clusters, not all clusters are represented. The association is sometimes criticised for not being representative and for being the spokesperson of the bigger clusters.

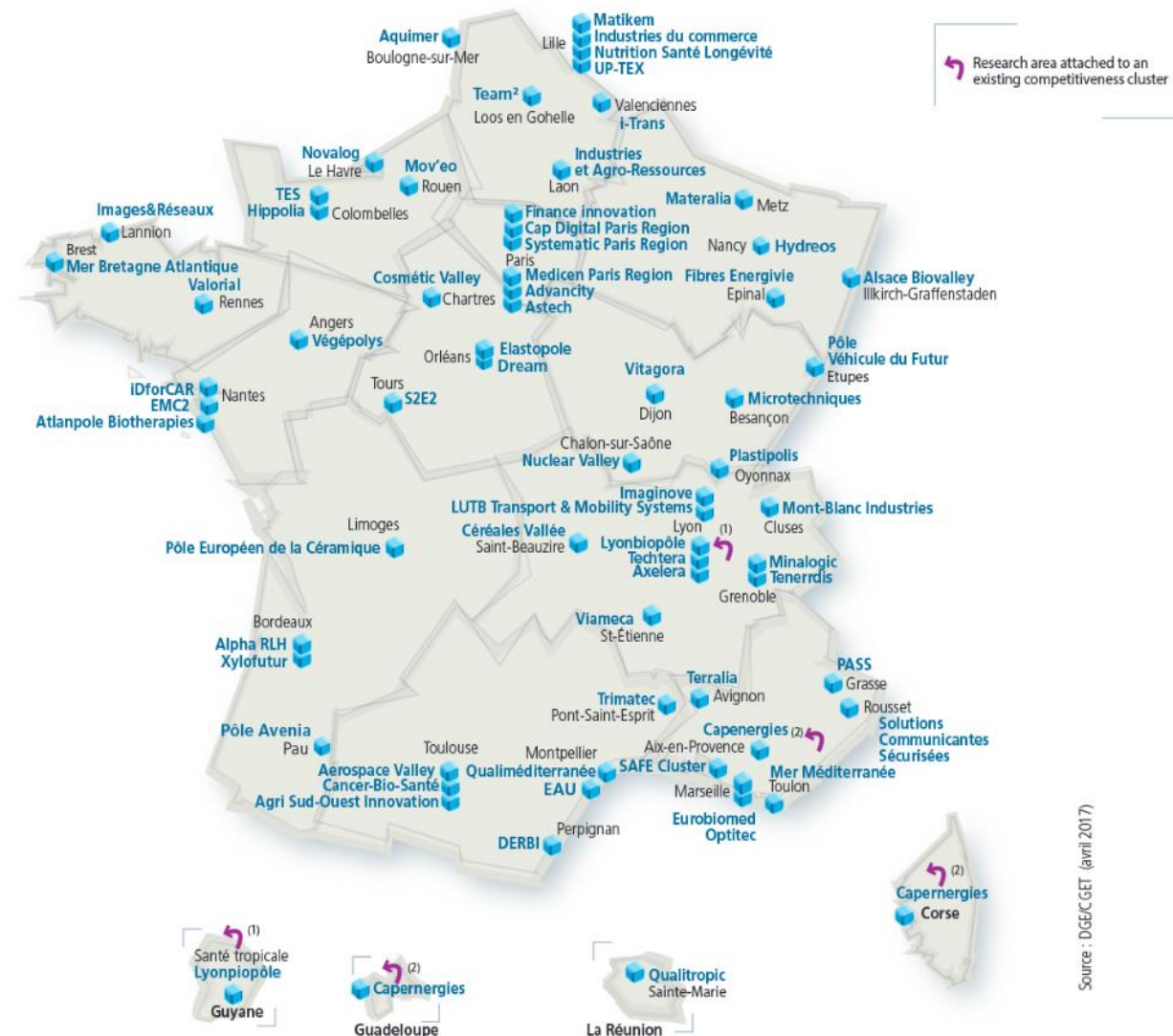
Key figures on the programme and key activities funded

The thematic coverage of the clusters is broad, and some clusters may cover several themes. It includes:

- Aeronautics and space (4 clusters);
- Agriculture and agrofood (12 clusters);
- Consumption goods (4 clusters);
- Bioresources (4 clusters);
- Biotechnology and health (7 clusters);
- Chemistry (4 clusters);
- Ecotech/environment (7 clusters);
- Energy (12 clusters);
- Engineering/services (7 clusters);
- Materials (11 clusters);
- Mechanics (6 clusters);
- Optics/photonics (2 clusters);
- Information and communications technology (11 clusters);
- Transportation (7 clusters).

There are currently 68 competitiveness clusters (see *Figure 1: Map of competitiveness clusters in April 2017* figure 1). There has been up to 71 clusters, but six were merged during the second and the third phase to form 3 clusters.

Figure 1: Map of competitiveness clusters in April 2017



Source: CGET.

There is no defined size for a cluster, and there is a great variability between clusters. Some clusters are responsible for the development of a small community of members, while for others, the community could amount to 400 members. Overall, the 2012 evaluation notes that 72 percent of the members are companies, with SMEs representing 80 percent of this number. On average, in 2011, a cluster counted 187 members, including 13 research organisations, 4 training organisations, 14 research and training organisations, 108 SMEs, 16 medium-size companies, 13 large companies and 19 other members.

One of the core mission of the competitiveness clusters is to contribute to the emergence of collaborative R&D projects. Some “funding windows” require their label for the selection of the projects they support. This label is perceived as an effective way of pre-screening, and potentially reorienting, the project. The competitiveness clusters have their own dedicated funding window, with the FUI, but can also label projects for other funding windows.

Overall, since 2005, the 22 FUI calls for proposals⁸⁸ supported 1,681 collaborative R&D projects, for a total of €6.8b, including €2.7b of public support (€1.7b by the State and €1b by local authorities). In addition, the National Research Agency funded more than 2,200 projects labelled by clusters, with €1.5b between 2005 and 2015, roughly one third of its budget.

The support to the policy by the State is done in two ways:

- Financial support for the functioning of the cluster and the development of the ecosystem. Initially, the annual State contribution was €12m as support for the animation and is currently comprised between €15 and €20m, which represents about 15 percent of the overall State support to the policy⁸⁹
- Co-funding of R&D projects, through an inter-ministerial fund (“Fonds Unique Interministériel”). Over the period 2014–2015, the amount given by the State to the FUI represented about 1 percent of all public support to the policy of innovation (including indirect support)

After the evaluation of the first phase showing satisfactory results, the State decided to continue with a second phase and allocate a total €1.5b for the “Cluster 2.0”, an amount equivalent to the first phase.

Over time, clusters have been invited to look for additional co-funding, both public and private. Private financing is expected to reach 50 percent in line with the State Aid rules. Although there is no target for the participation of other public funders, the regional authorities have been allocating an increasing amount, both as direct resources (including financial resources) but also as contributions to the financing of some R&D projects, through the FUI.

Despite the growing participation of regional authorities to the financing of the FUI, the overall level of funding dedicated to collaborative R&D projects labelled by competitiveness clusters has decreased over time. The public contribution to R&D projects support through this channel was €256m in 2008, €149m in 2011 and reached a record-low of €76m in 2017 during its 23rd call for proposals.⁹⁰ In the meantime, the Programme for Future Investments (“Programme d’Investissements d’Avenir PIA”) has emerged since 2010, without clear link with the decrease of the FUI. The programme funds R&D projects and structures, including projects that are potentially interesting for competitiveness clusters, even sometimes dedicated, and structures that could collaborate with competitiveness clusters (e.g. Technological Research Institute, Institute for Energy Transition). It however raises the questions over the complementarity of the competitiveness cluster policy with the emergence of these new tools and its sustainability, especially in light of the decrease of the amount of support provided to the competitiveness cluster policy.

Cluster categories: rationale, relevance, effectiveness

Initially, the programme formed three different categories of clusters during the announcement of the results. These categories were however not mentioned in the call for proposals. The policy distinguished between “global” clusters, “global vocation” clusters and “national” clusters. This categorisation aimed to identify clusters of a significant size, able to have a great international visibility and to become a focal point in their sector. Several criteria were used, including the weight of research and laboratories on the territory. These criteria were not made public and generated criticism. Initially, 7 clusters labelled “global”, 10 “global vocation” and 54 “national”.

⁸⁸ The analysis of the 24th call for proposals is currently undergoing.

⁸⁹ Between 2013 and 2015

⁹⁰ Between 2008 and 2013, the number of projects funded by the FUI decreased by 36% and the average amount of funding decreased by 27%

In 2008, an evaluation was conducted, both on the overall policy level and on the individual cluster level. The evaluation recommended the abolition of the “global vocation” category, to retain only the categories “global” and “national”, the former to be reserved for clusters whose innovation capacities in its field are among the world-leading stakeholders and whose thematics are sufficiently broad to ensure a global visibility. The “national” category should be given to all clusters not complying with one of these two conditions. The evaluation recommended to have 16 clusters in the “global” category, and 55 in the “national” category. Despite this recommendation, the initial “global”, “global vocation” and “national” categories were kept. The 2012 evaluation, two categories were proposed, “international competitiveness cluster” and “innovation and competitiveness cluster”, and to re-classify the clusters based on explicit and impartial criteria.

Over time, the initial classification of “global”, “global vocation” and “national” clusters has become ineffective, mostly due to fact that this classification was not resting upon clear criteria known by the stakeholders. The evolution of the markets, the clusters dynamic but also the structure of the clusters and the national strategy, also contributed to render it ineffective over time. For instance, the categorisation did not consider clusters belonging to one of the 12 strategic sectors identified by the 2010 General State of the Industries. Furthermore, the underlying idea of a competitiveness cluster was to take part in international outreach, and the label “national” could pose as an image barrier for national clusters. At this point, there was a willingness expressed from the national authorities to avoid differentiated treatments and to set all clusters on an equal footing. In addition, a modification of the cluster classification had been considered as politically damaging, and the classification was simply abandoned.

During the existence of this classification, the transition from one category to another was not planned. The two evaluation reports in 2008 and 2012 however proposed the evolution to only two categories, with suggestion of promotion for some clusters. However, during the time of existence, the clusters kept the categories they were assigned during the inception of the policy.

Selection procedure and criteria

In 2005, the government launched a call for proposals for competitiveness clusters, to foster synergy between research laboratories and training organisations on the one hand and companies on the other, defined by a geographical territory and business sector related topic.

The competitiveness cluster label was attributed by a decision of an inter-ministerial committee in charge of spatial planning and territory competitiveness, chaired by the Prime minister.

The specifications of the call for proposals established by the government in 2004 indicated four main criteria:

- A development strategy consistent with the economic development strategy of the territory
- A sufficient international visibility, on an industrial or technological level
- A partnership between stakeholders and a structured and operational governance
- An ability to create synergies in terms of research and development, and thus bring new wealth with a strong added-value

These broad criteria were not further defined and were not operationalised. It corresponded to a will of the government to provide the State a high degree of freedom in the selection process and in determining the number of clusters to be supported.

The selection process included a triple analysis:

- The analysis at the regional level, under the responsibility of the regional prefect

- The expertise of an inter-ministerial working group
- The expertise of an independent panel formed of qualified people, from the business and university sectors

Initially, regional authorities were not involved in the selection of the clusters, although their ownership of the cluster project was one of the underlying selection criteria. Similarly, their views could also contribute to the selection of a cluster. Most projects included a covering letter from regional and/or local authorities. Several presidents of regional councils wrote to the government in order to support the establishment of competitiveness clusters on their territory.

At the end of this selection procedure, 3 committees in 2005, 2006 and 2007 selected a total of 71 clusters. The number is higher than what was initially expected (about 15) but given both the enthusiasm in response to the call for proposals and lobbying from regional actors, it was deemed preferable to support more territorial initiatives.⁹¹ In total, 105 proposals were submitted.

While launching the second phase of the policy in 2008, the government expressed its intent to cover the themes linked to eco-technologies. In 2009, a new call for proposals was thus launched. In May 2010, 6 new clusters were labelled as competitiveness clusters, in the fields of water, waste management, building and energy. Unsuccessful candidates were invited to submit a proposal to the “company cluster” label (“grappes d’entreprises”).

Monitoring system

Evaluations

The only common system to monitor the progresses of the clusters are the periodic evaluations. At the end of the first (2008) and second (2012) phases, evaluations were conducted, covering both the national policy and the individual performance of the clusters. In both cases, it was recommended to pursue the policy with a new phase. In 2012, the evaluation also recommended for the third phase the establishment of contracts between the agent and clusters, connected to monitoring of performance through a mid-term evaluation.

The steering committee of the national policy is piloting these evaluations, under the operational guidance of CGET and DGE. Evaluations include desktop analysis (including databases), interviews with stakeholders at the national (e.g. ministries) and cluster levels, surveys, on-site visits and meetings with clusters’ stakeholders and public financiers.

In terms of results, the 2008 evaluation classified the clusters in three groups, in order to rank the individual performances of clusters:

- Clusters that have met the objectives of the policy (39);
- Clusters that have partially met the objectives of the policy (19);
- Clusters that would benefit from a re-organisation (13).

⁹¹ At this time, the devolution process had recently given the regional authorities (22 in metropolitan France) the competences of coordinating economic development activities. Clusters were deemed as a tool to undertake these activities. Almost all regions were awarded a competitiveness cluster on their territory.

The classification on individual performances led to the de-labelling of 6 clusters in 2010. At the same time, a new call for proposals was launched, leading to 6 new clusters, with one entering the “world vocation category”.

In the 2012 evaluation, the clusters were again classified, from high-performing to non-performing. Due to their recent establishment, the 6 new clusters were not classified. The clusters belonging to the non-performing category were given a probationary period of one year to establish a remedial plan, and risk losing the competitiveness cluster label if performance was not improved. No individual cluster lost their label, but some of them were invited to merge. Furthermore, the level of performance in some cases affected the level of co-funding from local authorities.

In 2016, a mid-term evaluation covering the individual performances of the clusters was conducted for the period 2013–2015. It was designed as a tool for clusters to measure their trajectory towards the achievement of the performance targets set for 2018. This evaluation did not establish a categorisation of the clusters, instead focused on the alignment of each cluster to the specifications of the third policy phase. As classification of clusters could potentially have strong impacts on both the actions and the visibility of affected clusters, no overall ranking was conducted. Given the recent regulatory evolution towards devolution (“Loi NOTRe”), there was a fear shared by clusters and regions that the State would only come to support high performance clusters in the future, and that less productive clusters would be entirely transferred to regions. The evaluation concluded that most clusters achieved the objectives set in their performance contract signed with the State and the regional authority. At the end of 2015, an average of 77 percent of their objectives were met, with four clusters below 50 percent fulfilment of objectives.

Performance indicators

In terms of indicators, the policy lacks a set of joint indicators to evaluate the performances of the clusters. At the inception of the policy, the clusters’ business models were not assessed. Over time however, this issue has become increasingly more important. A self-financing indicator is now common to all clusters. In addition, the third phase of the policy was supposed to tend towards a better harmonisation of performance indicators. Guidelines were established in support of this process, and clusters were given the opportunity to add additional indicators to a set of around 10 common indicators. Eventually, due partly to a adjustment of the performance contract to sector/cluster specificities and the implication of regional authorities, this harmonisation has not been fully effective. Beside “standard” indicators⁹² used during the periodic evaluations, there are discrepancies between what is monitored by the clusters, both in terms of volume and content.

In addition to the evaluation, the DGE (Ministry of Economy) undertakes an annual survey to collect data on a joint set of indicators. Indicators include resources (human, financial), number of projects funded, budget in relation to conducted activities, number of member etc. It provides an overview of the clusters’ activities, although there is an issue of lack of uniformity on these indicators over time. For instance, one cluster could count a university as one partner, while another cluster count institutions and laboratories of the same university as multiple partners. Since recently, some of the results of this survey are shared with other administrations during the technical committee.

⁹² Such as the number of R&D projects labelled or funded, within the framework of the FUI or not, the number of IP titles, the share of time spent of different kind of activities, the number of international partnerships, the evolution of members, the share of SMEs in the members or in the governing bodies...

Sustainability of clusters

There is no predetermined period of support to the clusters from the programme. The policy has been prolonged at two occasions. The decision for the renewal of the policy at the end of the third phase is due in 2018.

Although there was no set period for the duration of the policy, the State Aid regime used was valid for ten years. Since 2014, the exempted aid for innovation clusters is used to support clusters on their animation activities up to 50%. The understanding of the legal offices is that each new label given to clusters will renew the 10 years period. A renewal of the competitiveness cluster label is given after the cluster has been evaluated and exhibited satisfactory performance. The use of a new call for proposal to foster competition among established clusters and new candidates is considered for the eventual fourth phase of the policy.

On an individual cluster level, the continuity of the support might differ depending on the results of the individual evaluation. Individual contracts between the clusters, the State and the regional authorities have been established since the third phase of the policy. After the first evaluation in 2008, and a probationary period of one year, 6 clusters lost the competitiveness cluster label due to insufficient performance. Some of the activities of these clusters were integrated into other competitiveness clusters, while others were re-oriented towards the business clusters label or invited to transform into national centres, through other sources of public funding. Later during the implementation of the policy, some clusters were invited to merge, with the threat of otherwise losing the label.

The exit strategy of the business cluster policy

Unlike the competitiveness cluster policy, the business cluster policy had a set period. Since the call for proposals, it was indicated that the State support for the clusters would last for only two years, during the inception phase, and that clusters would then be expected to self-finance their activities. It forced the clusters to develop charged services to survive. In some cases, regional authorities have partially replaced the State when it withdrew its participation, to a level however insufficient to sustain the entirety of the original animation activities. While it withdrew direct support, the State contributed to the funding of an association, France Cluster, to support the network of business clusters and thereby sustain the policy it initiated. It allowed the State to decrease its support to less than 10 percent of the initial yearly funding.

For the third phase of the policy, the State has set an objective for all clusters to improve their share of self-financing, with a bottom line of 50 percent to be achieved. Self-financing might come from different sources, including yearly subscription or provision of charged services for participating organisations.

There are strong disparities between clusters in terms of subscription level and development of services. Some clusters might provide a service for free to an individual member that is charged for in another cluster. When forming consortiums for project proposals in response to calls issued by the FUI, some clusters impose a membership for one or even for all consortium members, including over several years if the project is selected.

In addition to member subscriptions and provision of individual charged services, it is however to be noted that self-financing also might include in-kind contributions. There are however differences in the policy of in-kind contributions between clusters, some do not allow in-kind due to apprehensions over a potential take-over by large companies better able to provide such contributions.

During the mid-term evaluation of the third phase conducted in 2016, it was noted that the average self-financing rate was 46 percent in 2015, with 28 clusters (out of 70 at the time of the evaluation) above the objective of 50 percent and 10 clusters which had not yet found an adequate business model allowing them to decrease their dependency to public funding.

Lessons learnt from the cluster programme

The different evaluations of the competitiveness cluster policy noted the effectiveness of the clusters' actions in terms of structuring the regional innovation ecosystem. Clusters acts as R&D&I catalysts and contributes to breaking down barriers in the field of R&D collaboration between large companies, SMEs and research organisations. The policy has been contributing to address some of the issues affecting the competitiveness of the French economy. The structural costs provided for animating the different territorial networks is below €20m per year, which is quite low (per supported entity) compared to other innovation policies, especially given the number of projects that has emerged and the international visibility it has generated. R&D projects contributed to intellectual property and innovation, with an average of 5 intellectual property titles submitted per 10 members, and 5 innovations per 10 members during the period 2013–2016.

The policy was reoriented during its third phase to in order to increase the level of performance, but the 2016 mid-term evaluation showed that few clusters succeeded in the process of transferring projects to products. This is partially due to a lack of skills and competence needed in companies to absorb results generated in R&D projects. The activities undertaken by the clusters have thus evolved over time, from an initial strong emphasis of support to collaborative R&D projects, to the increased focus of assisting SMEs in their development.

The new missions could however blur the positioning of the competitiveness clusters, especially in a changing ecosystem. Indeed, the competitiveness cluster policy was initially one of the major instruments of innovation support in France but major evolutions have occurred recently, notably under the Future Investments Programme, PIA. New structures have emerged to sustain innovation and the articulation with the competitiveness clusters need to be improved.⁹³ Although coordination between competitiveness clusters and these new structures was deemed possible, some of their activities might overlap and blur the legibility of the overall innovation ecosystem for external stakeholders.

Although the share of self-financing is increasing, competitiveness clusters remain too dependent on public funding. Some clusters have difficulties to find an adequate and sustainable business model. The dedicated fund to support collaborative R&D projects labelled by competitiveness clusters has been instrumental in the success of the policy, with 1,700 collaborative R&D projects supported in a 12-year period. This fund has however diminished over time, and clusters fear the loss of this devoted instrument, that in turn could undermine their relevance and offering for the members. The extension of the PIA to the regions could potentially be used in the future to fund R&D projects involving SMEs. It is however to be noted that the competitiveness clusters' members already have secured a significant amount of the PIA funds.

Although competitiveness clusters can be useful tools to stimulate innovation and collaboration between stakeholders, the State needs to better determine its role, whether in support of downstream R&D or in support of innovation ecosystems. In light of this experience, it is instrumental to clarify the positioning, the missions and the articulation of the clusters in the national ecosystems. Another point of improvement is the international and European dimensions, that only a minority of clusters has been involving actively.

The competitiveness cluster policy has however contributed to the creation of collaborative dynamics between private companies and research organisations around R&D projects in different territories and in

⁹³ The PIA has notably led to the creation of 14 "Société d'Accélération du Transfert de Technologies" (SATT), a type of French company that facilitates and develops the transfer of innovations derived from public academic research to the socio-economic markets, 8 "Instituts de Recherche Technologiques" (I.R.T.), technological research institute based on long-term partnerships between higher education organisations and companies in order to improve the Industry/Research/Training dynamic, and 12 "Instituts pour la Transition Énergétique" (ITE), technological research institute in the field of energy transition.

different sectors. However, the economic impact of these projects and subsequent innovations, and their reach of the market, is however uncertain at this point.

Overall, the economic impacts of the French competitiveness clusters are still vague. An econometric analysis of the economic impacts is currently being conducted and results are expected for the end of 2017. The previous evaluations in 2012 or 2016 were focusing on following the clusters activities and did not measure the direct and indirect impacts of the clusters in a wider context.

The cluster policy has a positive effect on companies' R&D expenditures, with a substantial leverage compared to non-cluster members, for one euro of additional public funding, almost three euros were disbursed in R&D spending. However, no significant results were detected further down the value chain of innovation (e.g. turnover, number of IP titles, increase in staff etc.)

An INSEE study notes that companies that are members of competitiveness clusters have received more subsidies and benefited from more tax exemption through the "Crédit Impôt Recherche" (CIR), a fiscal tool that was set up around the same period of the policy. In 2009, an average member of a cluster had expenditures on R&D amounting to €116k, a substantial upshift of the subsidies received.

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List of interviewees

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