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SCOPING PAPER REPORT

SMART ECONOMIC RESTRUCTURING IN NORWAY - CONNECTING MICRO AND MACRO

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REPORT

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EXECUTIVE SUMMARY OF SCOPING PAPER

The OECD review of innovation policy in Norway 2017 identified several challenges for the Norwegian economy which are linked to the issues of too much sectorization and too much reliance on oil and gas. Overcoming these challenges implies a need for rebalancing the economy in the direction of exploring new avenues and diversifying Norway's economy. A solution for restructuring the economy towards that direction through research and innovation (R&I) is Smart Specialisation based on Entrepreneurial Development Processes (EDP). EDP means focusing on the exploration of new growth opportunities and investments in emerging rather than mature markets, through various forms of cooperation between entrepreneurs, public sector policymakers and academia.

The Norwegian Research Council should discover and address tensions between exploration and exploitation in innovation strategies in the business sector and in national-level policymaking. It must be able to team up with and support entrepreneurs and firms to explore new, so far unused and unexplored opportunities in the economy. This means that the Norwegian Research Council should be able to act based on an empirically grounded understanding of the market failures which prevent firms from discovering and exploiting new opportunities. In this way, further research and experimentation should contribute to unlock the hidden potential of the Norwegian economy, given its current strengths.

This scoping paper identifies and describes approaches that are relevant for diversification driving growth in the Norwegian economy. It outlines the preconditions for cross-sector innovation and the proactive role of the public sector in restructuring the Norwegian economy. A brief summary of the research agenda from this scoping paper is below:

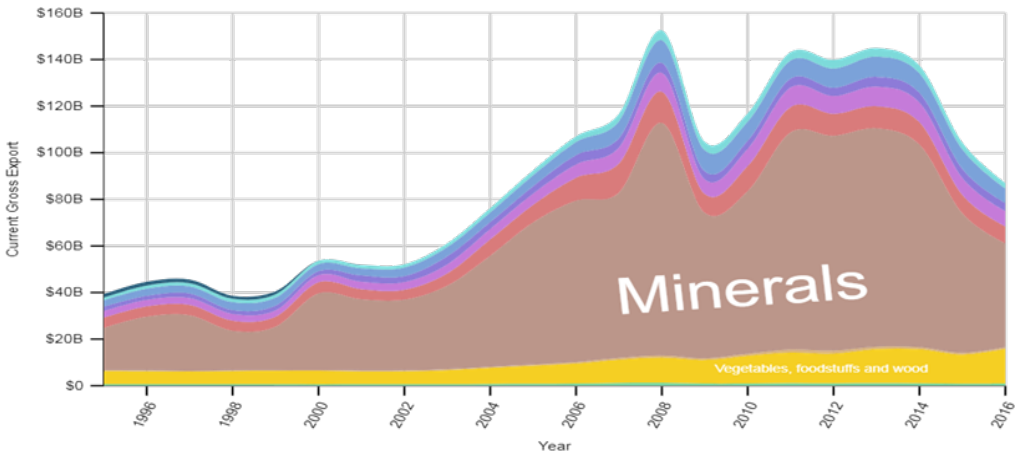
Transition to a more diversified economy driving economic growth			
Objectives	**Challenges**	**Related questions**	**RESEARCH AGENDA**
Promote the diversification of the economy	Excessive reliance on specialization on oil and gas	1. How to diversify Norwegian economy?	Smart Specialisation Strategy (EDP, Triple Helix, science and innovation policy, climbing up the value chain)
Foster a more competitive innovation system	Sectoral systems of innovation	2. What is the precondition for cross-sector innovation?	Innovation platforms supporting entrepreneurial discovery processes, cross sector innovation networks
Advance inter-sector policy coordination	Ministerial coordination	3. Who could be the coordinator?	A stronger role for the Norwegian Research Council

1. INTRODUCTION

1.1 AN OVERVIEW OF NORWEGIAN ECONOMY

The competitive position of a national economy may be measured through its export (Hausmann, Hildago et al., 2014). The economy of Norway depends on the extraction of natural resources, supported by sectoral industrial clusters and networks of innovation (OECD, 2017). However, the export income from the production of oil and gas —Norway's main source of income—is shrinking due to falling global market prices of the commodity. The graph below illustrates the Norwegian export sectors excluding services during the last two decades (1996-2016) which was dominated by minerals, mostly composed of oil and gas (O&G).

Figure 1. Export excluding services from Norway 1995-2016 by main sectors (SITC4).



Source: Atlas of Economic Complexity

Figure 1 illustrates the rise and fall in export income from the core industrial sector in Norway. In the short term, the downfall shown by the graph creates problems that go beyond the oil industry per se, and reaches related areas, such as machinery and transportation. This scenario demands the exploration of new growth possibilities for sustaining economic activity in the long term, both in sectors related to oil and gas, as well as in other strong export sectors.

Figure 2. Export excluding services from Norway 2016 (SITC4)

Source: Atlas of Economic Complexity

Figure 2 shows what the main sectors are in the Norwegian economy in 2016. The largest gross export sector is by far that of fuels, lubricants and related materials (mostly crude oil and natural gas), which accounts for 49,32%. Food (mostly seafood) is the second largest with 14,8%, followed by machinery and transportation (11,36%), manufactured products (9,8%) and chemicals (6,88%). This figure presents a snapshot of the Norwegian export sectors in 2016, illustrating what other strong economic sectors in Norway are, aside from oil and gas.

The OECD has recently performed an evaluation of the Norwegian system of innovation and economy (OECD, 2017). It builds on an extensive analysis of economic indicators (with a particular focus on research and innovation) as well as a wide-reaching dialogue with core informants. The report states that Norway faces a "triple transition imperative" (p.13):

1) Shifting towards a more diversified and robust economy: *"A strong research and innovation system will be needed to transform the economy, which is still highly dependent on O&G"* (p.13).

2) Moving towards a more competitive, effective and efficient innovation system: This system needs to consider *"sufficient incentives and checks and balances for better performance in research and innovation"* (p. 20).

3) Supporting research and innovation that can confront societal challenges, simultaneously with the restructuring process. Research and innovation need to solve *"an array of societal challenges (climate change, food security, ageing, health and so on)"* (p. 20) during the abovementioned structural transformation.

The challenge of addressing the "triple transition imperative" lies in the Norwegian institutional and economic structure. a sectoral system of innovation with strong ministries at the central level of the state, oriented towards sectors extracting natural resources. This leaves Norway with a weak ability to coordinate cross-sector innovation that can drive diversification. In the words of the OECD:

> *"Norway has a stable and functional, but highly sectorised, policy framework that strongly shapes science, technology and innovation policy. Where this framework, governed by the so-called "sector principle", may have been advantageous in the past to sequester research in various fields throughout the policy spectrum, Norway's imperative for an economic transition has increased the need for horizontal, interministerial co-ordination and a more active and integrated setting of strategic priorities. Some interministerial co-ordination processes, including in the context of the preparation and implementation of the Long-Term Plan, "soften" the practice of the sector principle.*
>
> *While government actors can coordinate specific operational issues to ensure continuous incremental progress under the current setting, broader strategic issues are not as well covered, including long-term options with alternative paths, possible directions of which priorities to choose, or larger initiatives combining funding with regulatory issues and cross-policy approaches. The absence of a top-level referee or central priority-setting mechanism at the top government level shifts the task of co-ordination to the agency level, which puts the RCN under pressure. This model of co-ordination may also leave only limited room for policy innovation and cross-cutting activities." (OECD, 2017, p. 15).*

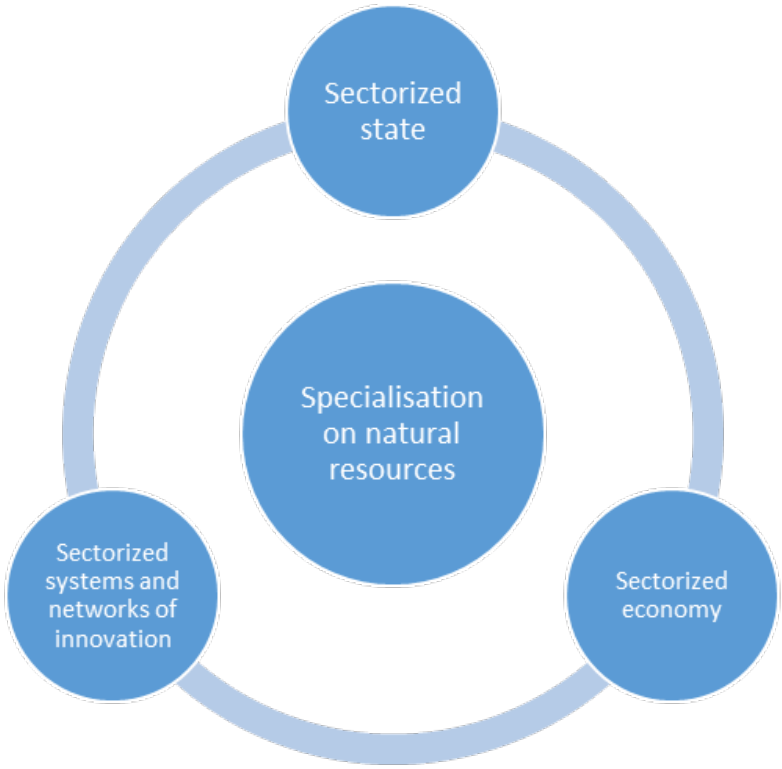
The OECD identifies sectoral institutionalized arrangements with weak mechanisms of cross sector coordination at the central level of the state as a challenge. There is a self-reinforcing quality between the central level form of government and the economic structure that relies heavily on natural resource-based industries. These systems of complimentary institutions develop distinctive kinds of market rules and actors as well as patterns of economic organization (Whitley, 2003). These rules and patterns tend to be self-reinforcing and taken for granted, creating the risk of path lock-in for Norway. Therefore, the OECD outlines a broad strategy of transition based on the three abovementioned imperatives, where different challenges are addressed in parallel.

This is the point of departure for our scoping paper. We use the results from the OECD 2017 report to identify the objectives for the restructuring process in Norwegian economy, which will be presented in table 1 of the next section.

1.2 THE NEED FOR RESEARCH ON RESEARCH AND INNOVATION

Thanks to high oil and salmon prices, the institutional complementarities of sectorized state, sectorized systems and networks of innovation, and sectorized economy (figure 3) have created success stories for many years, reinforcing the belief that the existing solutions are working well. Processing industries, such as seafood and oil and gas, are characterized by impressive strategies of path renewal and strong sector systems of innovation, resulting in highly productive and competitive global market achievements. This high productivity has made Norway one of the successful raw material producers, like Australia and New Zealand.

Figure 3. Institutional complementarities



However, the ground conditions are no longer the same, this challenges the existing setup of the Norwegian economy. With the global falling prices of O&G commodities, Norway must face the triple transition imperative pointed out by the OECD (2017). One initiative in this direction is the Long-Term Plan for Research and Higher Education 2015-2024 that the Norwegian Government launched in 2014. This strategic plan, built around *"three overarching government objectives for science, technology and innovation policy: developing research communities of outstanding quality; enhancing competitiveness and innovation; and tackling major societal challenges"* (p. 13), also advances the calls for exploration and new relations between science and business in innovation policy.

In brief, the Norwegian economy needs both the exploitation of its strengths in order to take advantage of its strength in O&G sector, and the exploration of alternatives, so as to respond to the challenge of transitioning in the direction of a redesigned economy. The approaches of exploration and exploitation have long been discussed by scholars, the first being related to the discovery of new paths, and the latter to the refinement of the existing ones (March, 1991). The relation between these approaches is complex, as scholars argue that investing in either one tends to crowd out the other (March, 1991; Tushman and O'Reilly, 1996). Innovation systems oriented towards exploitation seek innovations along the established path, and this may restrict more radical innovation and diverse entrepreneurial activity. Therefore, it is important for the restructuring process to balance both activities, exploration and exploitation, of the economy to ensure the sustainable development of Norway.

The balancing act needs a better coordination between the micro (innovation / entrepreneurial actors) and macro (policy) level, opening up for a stronger emphasis of exploration through partnerships between public sector institutions, entrepreneurs and firms who knows the market, and researchers. We will refer to these partnerships as coordinators of entrepreneurial discovery processes, looking for and opening new business areas.

1.3 OUTLINE OF A RESEARCH AGENDA

The three facets of transitions laid out by the OECD in its transition imperatives open related questions for research. We reframe them into three objectives for Norwegian economic restructuring, and analyze the challenges associated with each imperative and identify the corresponding research agenda in Table 1. The challenges depend on changes both in the macro level of structures and the micro level of actors (i.e. firms and entrepreneurs), as the latter make new decisions and engage with new business models. These micro and macro changes are interrelated. Therefore, the overall research problem tackled in this report is "How are the innovation activities at different levels interconnected in the process of economic restructuring in Norway?" From this investigation, we seek to offer recommendations referring to how policymakers and innovation actors can co-design support mechanisms for successful economic restructuring. It is important to clarify what is meant by macro level and micro level in this report. We use macro level in reference to policy-makers, as the broader system of innovation with its policies and strategies that come from government actors. Meanwhile, micro level refers to individual actors, such as firms and entrepreneurs, who perform regular innovation activities that contribute to the reconfiguration of the Norwegian economy. Table 1 summarizes the research agenda proposed in this report.

Table 1. Outline for a research agenda

Transition to a more diversified economy driving economic growth		
Imperatives	**Challenges**	**Research agenda**
Promote the diversification of the economy	Too much specialization on oil and gas	HOW? How can the Norwegian economy diversify and develop new domains, based on existing strengths? Which approach to choose? Which domains should we focus on next?
Foster a more competitive innovation system	Sector systems of innovation – and weak cross sector innovation capacity	WHAT? What are the preconditions for a transition towards cross-sector networks and systems of innovation at the national/ regional level?
Advance inter-sector policy coordination	Ministerial coordination – weak central government level	WHO? Who could be the coordinator in this transition process? What is the coordinator's role for connecting public authorities, R&D institutions, and innovation firms in the transition?

The research agenda identified in this scoping paper is to answer these three questions:

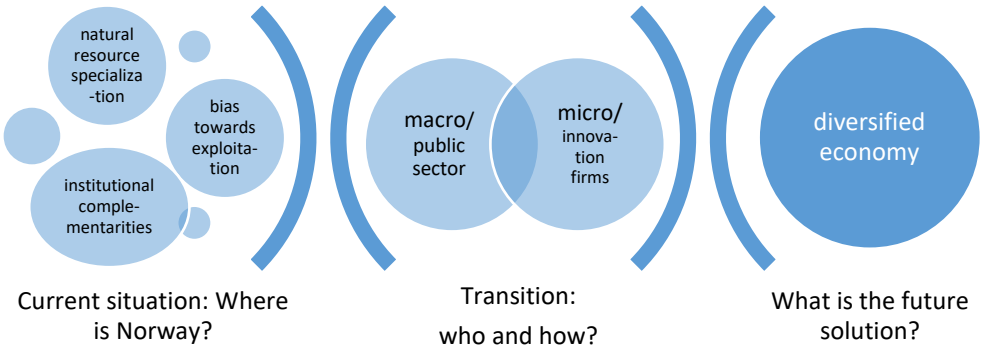
1. HOW? How can the Norwegian economy diversify and develop new domains, based on existing strengths? The first step is to identify the current position of the knowledge domains supporting the global market competitiveness of the Norwegian economy seen in an international comparison. We discuss this question from the point of departure of theories of smart specialization and related product space complexity models and indicators.
2. WHAT? What are the preconditions for a transition towards cross-sector networks and systems of innovation? We discuss this question in relation to the concept of innovation platform, which is a common knowledge space for innovation and new knowledge creation.
3. WHO? Who could be the coordinator in this transition process? We discuss the role of the research councils in connecting micro and macro levels in the process of economic restructuring.

In the next part, we present theoretical perspectives responding to our research questions and explain our approach combining several research streams in the existing literature.

2 THEORETICAL PERSPECTIVES

The starting point for implementing the transition towards a more diversified economy recommended by the OECD is identifying the theories and models which could help define and measure where the Norwegian economy is currently located and identify how the transition can be organized.

Figure 4. Conceptual steps for answering the research question



2.1 BACKGROUND: WHERE NORWAY IS

Before applying theory to answer our research question, it is beneficial to understand the current situation of Norway by answering the question of "Where is Norway in terms of frequently used indicators of innovation?"

In the toolbox of OECD and EU science and innovation policy indicators focusing on national systems of innovation, the Frascati Manual (OECD, 2015) and Oslo manuals on measuring innovation (Mortensen& Bloch, 2005) loom large. In the Frascati Manual, the GERD indicator (the share of GDP of a country invested in R&D) is seen as a crucial macro level measure explaining the level of investments of R&D of the country. GERD statistics for Norway and other OECD countries are published annually by the Norwegian Research Council[1].

There is an intuitive explanation to the impact of GERD. If an innovative firm is located inside a country with a high score on GERD, it is enjoying institutional frameworks, labour markets and networks of innovation which to a large degree exploit scientific knowledge. A high GERD national economy is likely to breed firms and clusters with high R&D investments. However, if a similar firm is located in a national economy with low total investments in R&D (low score on GERD), the opposite is likely to be the case. There might be innovative networks and scientific knowledge at hand, such as inside the advanced sectors of that economy, but these high-tech micro-clusters might be compared to isolated islands. Over time, firms adapt to different contexts. The innovative firm in a low-GERD economy is likely to outsource its R&D to a place where networks and labour markets are more enabling, providing the right skills and inputs for innovation. Firms adapt to different macro level contexts and grow in different directions, using the advantages of different locations.

With the goal to challenge the innovation leading position of USA, the European Union developed Lisbon policies which aim to increase GERD. Member countries lagging behind were encouraged to invest more in R&D in order to increase GERD. Norway used to be lagging behind the OECD and EU averages. In Norwegian science and innovation policy, this became an argument for increased state investments in R&D.

[1] Det norske forskningsog innovasjonssystemet – statistikk og indikatorer 2017, Norges Forskningsråd

It has long been pointed out that the Norwegian model (Asheim & Mariussen, 2010) is characterized by specialisation on raw material extraction. With some exceptions, Norwegian raw material processing focussed on the bottom of the value chain (crude oil, round, frozen fish), with limited efforts to climb into more advanced and complex products (Mariussen, 2015). This specialisation was and, in many cases, still are profitable for micro level actors, i.e. innovation firms. In Norway, we have an economic structure which provided incentives for micro level actors to continue exploiting natural resources, but these incentives are changing due to the change in global trend which emphasizes on sustainability.

When it comes to public and private investments in R&D, according to the OECD GERD indicator Norway is now at the OECD average, with roughly 1.97% of GDP invested in R&D (Norwegian Research Council, 2017). Norway's business R&D spending has been one of the fastest-growing in recent years, with an increase of 12% between 2014 and 2015 (9% at constant prices). As in other countries, its service industries have experienced the strongest growth in R&D, and now account for more than half of private R&D. This points to the right direction. However, we need to analyze the distribution of R&D investments within different actors in Norwegian economy for a more precise picture.

Distribution of R&D investment in triple helices:

The Triple Helix (TH) model assumes the driving force of economic development is the creation and transfer of organized knowledge generated by key actors: University (Science), Industry (Business), and Government (Governance) (Leydesdorff, 2010; Virkkala et al, 2017).

GERD statistics may be used to analyze the distribution of R&D between firms, R&D institutions and the public sector (the triple helix actors). If we compare countries with low and high GERD, there is an important change taking place between these three helices. The proportion of R&D investment allocation between the triple helices depends on the overall GERD indicator of the country.

Figure 5, illustrating the percentage of R&D carried out in public sectors by GERD, shows that countries in which the main part of research is undertaken in public sectors has low GERD indicators. For example, Argentina, Mexico and Rumania have very low GERD indicators compared to other countries. Their R&D investments are integrated into the state.

Figure 5. Percentage of R&D carried out in public sector by GERD in OECD-related countries

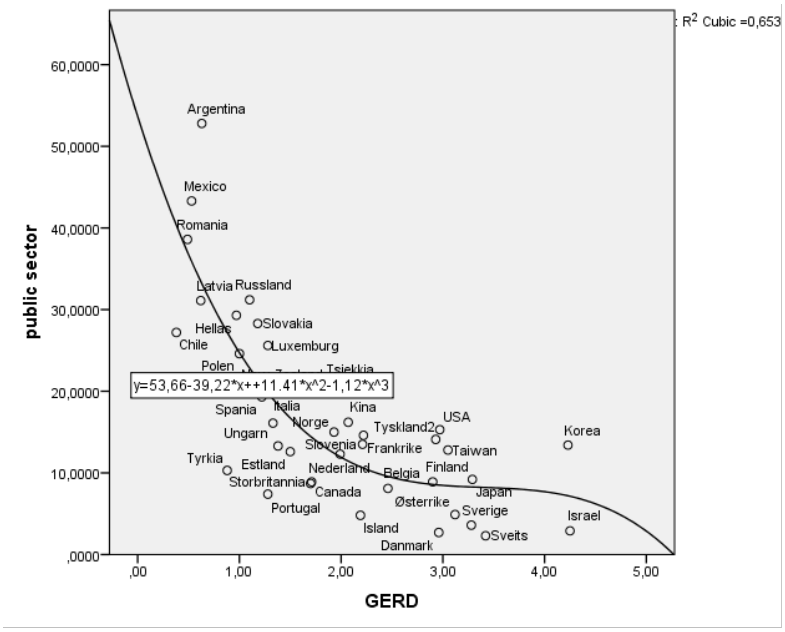


Figure 6, illustrating the percentage of R&D carried out in research institutions by GERD, shows that countries in which high proportion of research is undertaken in R&D institutions has medium GERD indicators. For example, Luxemburg, Portugal and Slovakia.

Figure 6. Percentage of R&D carried out in research institutions by GERD

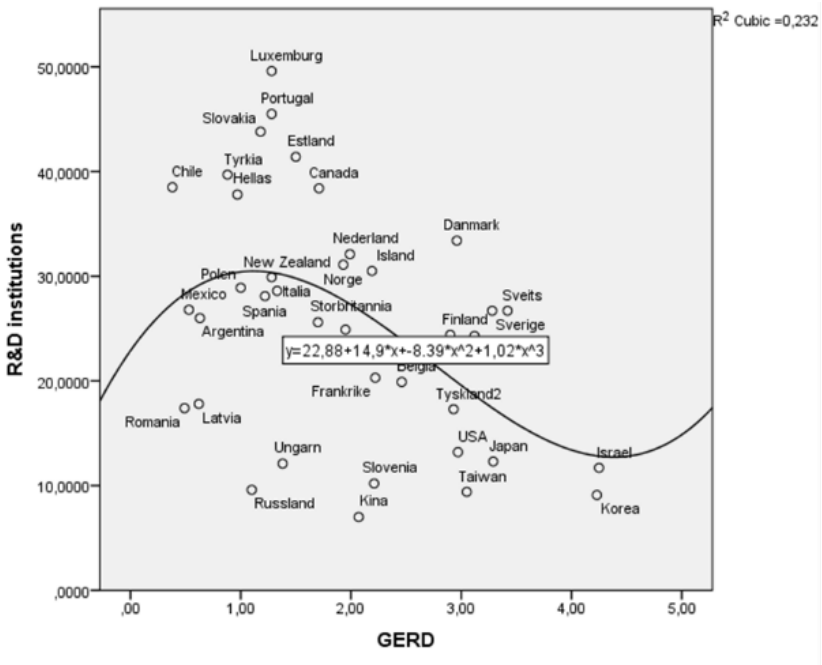
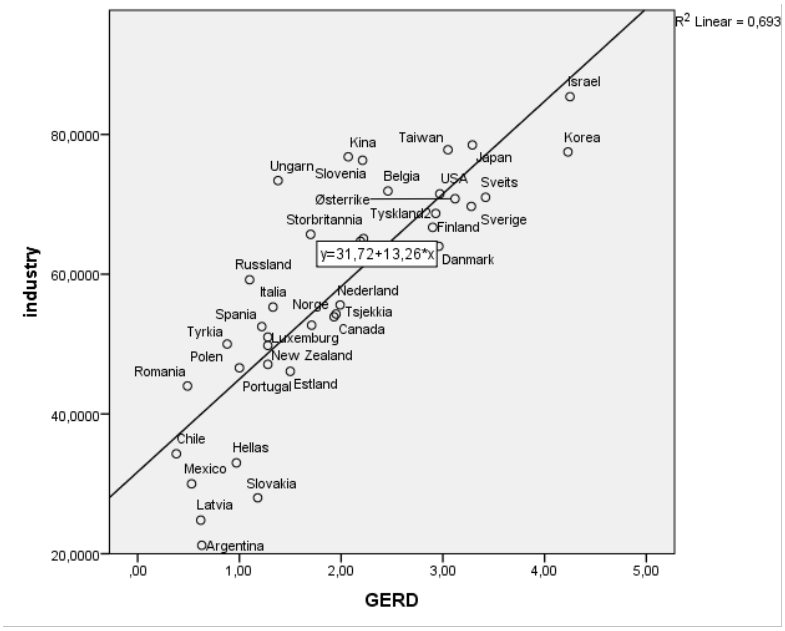


Figure 7, illustrating share of R&D performed in firms by GERD, shows that countries that have high level of R&D (between 60-80%) carried out by firms are countries have high overall GERD indicators. This includes countries such as Korea, Japan, Switzerland, USA, Germany, Taiwan,

Sweden, Finland and Denmark. In this picture, other countries, such as Argentina, Latvia, Slovakia, Greece, Mexico and Chile, have low level of total national investments in R&D (GERD indicator) as well as small shares of R&D carried out in firms.

Figure 7. Percentage of R&D carried out in industry by GERD



When it comes to GERD indicator, Norway is in the middle. But the three figures reflect that the Norwegian state has fairly high investments in R&D carried out in universities and other R&D institutions, while Norwegian firms have moderate to low R&D investments. Again, this is typical for countries with a high reliance on natural resources. It shows that universities and other R&D institutions play a more important role. However, a country could not and should not send more money to public sectors or universities for conducting R&D. Increasing R&D investment should be relied on micro level actors, i.e. innovation firms should be the main actors to perform R&D.

As shown in figure 7, countries with high levels of GERD increasingly depend on research undertaken in firms. In the Nordic countries with higher GERD than Norway, such as Sweden, Denmark and Finland, as well as in Austria and Switzerland, universities still carry a substantial part of national R&D. In several of these countries, we find deep integration between universities and firms with high R&D investments. We refer to this as “connectivity”, and “platforms”. Our main argument says that, if Norway wants to move up in GERD indicators, it should increase R&D investments in firms, and create deep integration between public sector, universities, and firms by creating “connectivity” and “platforms” for innovation.

2.2 THEORETICAL PERSPECTIVES FOR ECONOMIC RESTRUCTURING

The challenges of development economics lie in "the formulation of economic theory", and "the application of policy" which help to understand and solve the core problem of development (Thirlwall, 2003, p. 21). The essence of economic development is "structural change: it entails moving workers from traditional, low-productivity activities to modern, high-productivity activities that are quite different in terms of location, organization, and technological characteristics" (Rodrik, 2014, p. 23). Successful structural transformation requires a growth strategy, but there would be no one-size-fit-all recipe or blueprint of this nature. We present recent economic growth strategies and discuss the conditions under which these strategies hold.

2.2.1 DIVERSIFICATION THEORY

Economic growth could be achieved through the combination of specialization and diversification based on Rodrik's (2004, 2014, 2015) theory. His model of growth is based on analysis of national sector statistics, with a focus on the balance between specialization and diversification. According to Rodrik, the driver of growth in a specialized economy is seen as entrepreneurs (for instance entrepreneurs in an industry producing copper ore) who are able to apply what they know (such as tacit and codified knowledge of their metal) in a new, related direction, and produce more complex products (such as various copper products). The context of this process of growth is the macro level structure of the economy, which defines the competences and skills of the entrepreneurs.

This national structural macro level creates preconditions for micro level discoveries, leading to a "self-discovery" of the hidden possibilities within the existing domains. The entrepreneur discovers how to apply these strengths in new, related business areas, for instance in other sectors, or through climbing in the value chain in the sector. This might mean that a raw material producing specialist (such as a crude oil or copper producer) is climbing in her value chain and developing networks of innovation into new sectors, where refined products or components might be used by new customers.

Rodrik's theory is referred to both in product complexity theory (Hausmann, 2017) and in smart specialization (Foray, 2015). We look at these two perspectives in relation to Norway position.

2.2.2 COMPLEXITY THEORY

Product space theory is developed by Hausmann through research of economic development in 122 countries during the last three decades, applying export statistics. In this theory, country growth expectations can be derived from product complexity index, and country complexity index (Atlas of Economic Complexity[2]). It understands growth from the perspective of the potential of a given national economic structure to innovate and grow through diversification or related varieties.

A complex product is a product which may be used by many different customers in different sectors. For example, in the Atlas of Economic Complexity, the product with highest complexity is "Endless bands of copper wire for machinery" (HS4 code 7414) with a complexity ranking of 6.52. Copper wire is produced in the metal sector, but it is used in most products involving

[2] http://atlas.cid.harvard.edu/

electrical components across a broad range of sectors. As a comparison, crude oil has a complexity code of -3.86. Crude oil has only one type of customer, oil refineries. As oil climbs in the value chain, it may be used to produce products with higher and higher complexity, such as plastic, which may be used across several sectors producing complex products, such as cars and mobile phones.

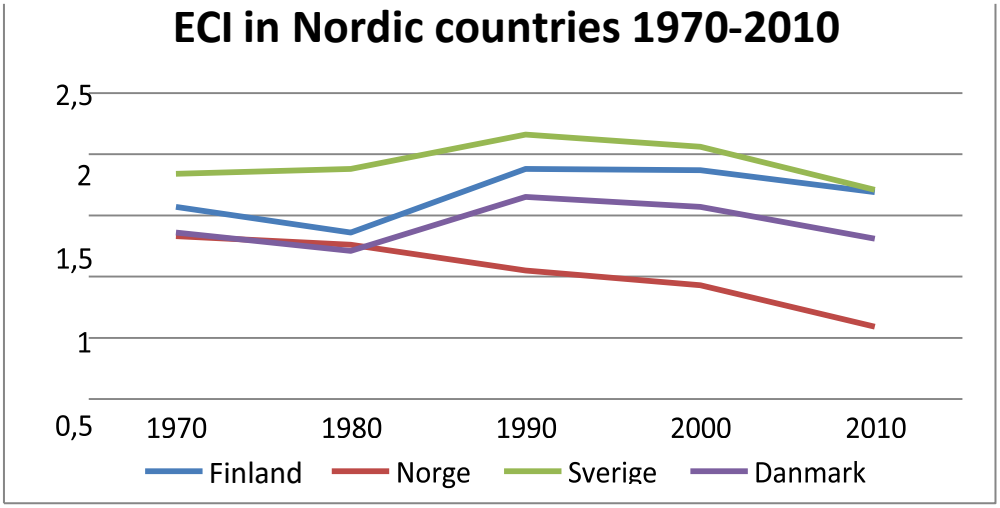
Some countries, like Norway and Chile, specialized in products with low complexity, such as crude oil and copper ore. This specialization on natural resources may lead to the sectoral systems of innovation, economic organization in sector-based clusters, and sector based political institutions. This has been mentioned in the OECD's report regarding Norway innovation system.

The second index, economic complexity of a country (ECI), is computed based on the diversity of exported products and their ubiquity, which is calculated by the number of the countries able to produce them and those countries' complexity (Hausmann, 2017). Intuitively, the country complexity index or ECI may be seen as an indication of diversification and cross sector networks in the national economy and systems of innovation. The highest score on country complexity is Japan, with a score of 2,26. The lowest among 122 countries in 2016 is Nigeria, with a score of -2,2500. The economy of Nigeria is dominated by one big export sector, oil and gas. In 2016, Norway was number 25 with a score of 0,9470. (Source of data: Atlas of Economic Complexity)

Countries may grow by increasing their complexity. They may do that by climbing in value chains of their raw materials, and by developing horizontal networks between their raw material clusters and other sectors. Countries who are using this mechanism of growth tend to reduce the relative part of raw materials and instead increase export of more complex products. Examples of countries who experienced this kind of growth through increased complexity is Denmark and Finland during the 1980s. This was the period when Denmark was able to diversify away from a strong dependency on food (agriculture and fishing) and grow new complex export industries. This took place in sectors which had been a part of the food and maritime industries, such as mechanical industries and chemical industries. These complex products were also enjoying deeper integration into the larger European economy, through Danish membership in EU. In the case of Finland, the 1980s were the golden years of the pulp and paper cluster, which replaced export of timber with paper. The pulp and paper cluster were highly diversified and as in Denmark with the food cluster, it could grow other export sectors with complex products, such as mechanical industry, chemicals and ICT.

How about Norway? What is the current situation of Norway complexity index compared to other Nordic countries? Figure 8 shows that the complexity Norway had during the 1970s was comparable to Denmark and Finland, however, the divergence started in 1980.

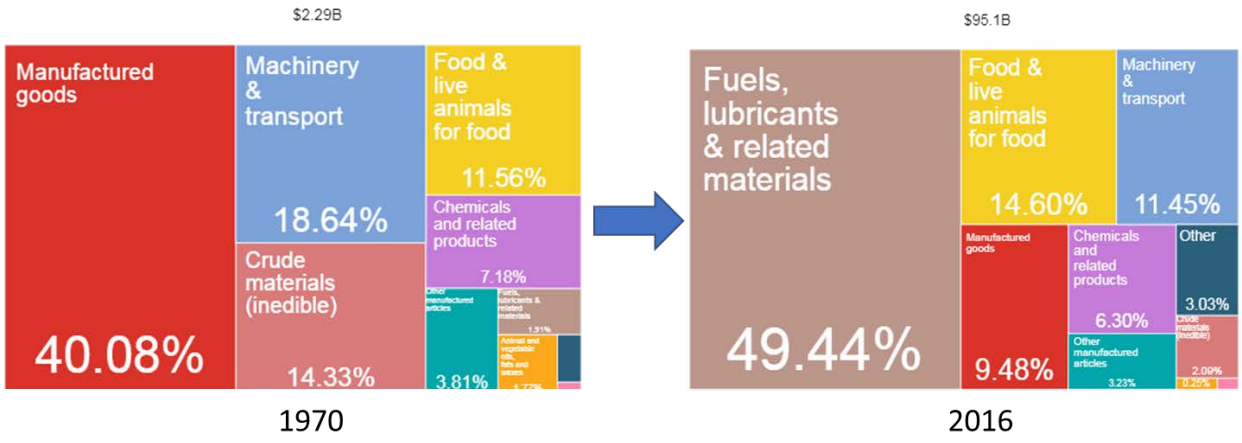
Figure 8. ECI in Nordic countries 1970 - 2010



The divergence started when Norwegian incomes from the oil sector became dominant. What could be the explanation for the reducing Norwegian ECI reduces over time? Following is our rationale to explain this phenomenon: O&G industry has crowded out other industries, and thus has reduced the Norwegian economic complexity. Oil is much better paid than timber and food. At the same time, oil attracted the Norwegian mechanical industries, during a period when ship building had passed its peak. Once the mechanical industries succeeded in entering the oil and gas cluster, they developed sophisticated organizations with advanced products and high levels of cost. This made it hard to combine oil and gas with other sectors, or to grow horizontal networks across sectors as mechanical industries did in Finland and Denmark. This is consistent with findings from research on structural impacts of high levels of income from natural resources (Bahar et al., 2016). High levels of salaries and high investments force such countries to focus on capital intensive goods, such as highly productive processing of raw materials with a minimum of labor, or highly technologically differentiated goods, such as products from advanced mechanical industries. As a result, Norway has limited number of high complexity products and low index of country complexity.

This can be illustrated by figure 9 below which compared how export sectors have changed in Norway from 1970 to 2016.

Figure 9. Changes in Norwegian export sector from 1970 - 2016



In 1970, Norway had a large sector with manufactured goods. It was reduced from 40,08% of export in 1970 to 9,48% in 2016. In relative terms, food production (salmon farming), which is highly capital intensive and automated, is a survivor. Machinery and chemicals are also surviving. Some of the firms in these sectors are highly sophisticated and highly productive innovators, and accordingly relatively independent of high labor costs. As a result, Norwegian economy is characterized by OECD report as highly sectorized, following the practice of "sector principle" (OECD, 2016, p.15)

In brief, according to complexity theory, Norway needs to increase the country complexity index. This theory stays within the original emphasis on growth driven by self-discovery defined by the national industrial structure, based on export statistics, however, it does not offer the mechanism to make this happen. On the other hand, smart specialisation theory of Foray (2015) explains how the basic mechanism of growth through self-discovery driving diversification is used in advanced countries with firms applying R&D investments. Here, self-discovery and innovation through related varieties is backed up through a modern form of R&D policy referred to as Smart Specialization and Entrepreneurial Discovery Processes (EDP). We elaborate this theory in the next section.

2.2.3 SMART SPECIALISATION IS COMBINING COMPLEXITY WITH SCIENCE AND INNOVATION POLICY

The appropriate strategy to increase the emphasis on exploration in an advanced country is smart specialization, which promotes a new type of self-discovery, the "entrepreneurial discovery processes" or EDP (Foray, 2015). EDP is a model of growth through specialisation leading to diversification, with reference to Rodrik. Foray positioned this model within the context of policies of science and innovation. Whereas an entrepreneurial self-discoverer in an emerging economy may be seen as restricted by her existing competencies, EDP in advanced economies may use science to expand the scope of the "self" which enables a discovery. In this expansion of the scope of exploration, science plays an important role.

Accordingly, EDP engages with science in a way which makes it possible to move beyond the strictly limited parameters of growth options outlined in the complexity model of Hausmann. Intuitively, the codified language of science makes it possible to combine forms of knowledge which are too distant in the complexity model. Science may be introduced into self-discovery in different ways. Above, we saw that advanced countries with high levels of GERD also have large R&D investments made by firms. In those economies, entrepreneurial discoveries may be done inside large corporations. Restructuring may be market driven. In countries like Norway, entrepreneurial discoveries must be based on triple helix cooperation since Norway can leverage its strong R&D investment in public sectors and universities.

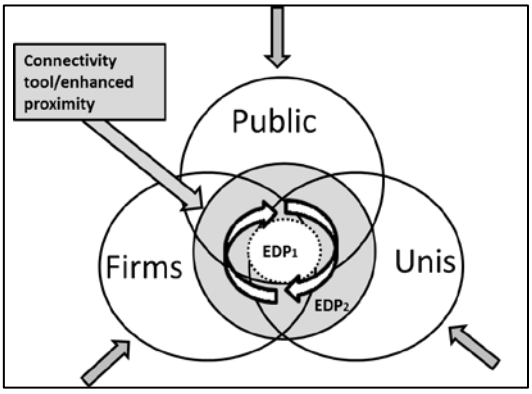
Innovation/entrepreneurial actors are constantly struggling with managing the tensions between exploration and exploitation, which are conflicting yet complementary activities (March, 1991). Exploration is the core activity of the entrepreneurial discovery process while exploitation generates income for entrepreneurial actors. These two activities are conflicting in nature and compete for resource allocation, organizational inertia, and desirable organizational outcomes (Lavie et al., 2010). Focusing on one activity may squeeze out the other activity (March, 1991; Tushman & O'Reilly, 1996). As a result, actors might be locked in the competency trap where exploitation drives out exploration, or the failure trap where exploration drives out exploitation

(Levinthal & March, 1993). This problem is expected to be at the forefront is countries like Norway where there are few large scale, highly innovative corporate actors doing discoveries all by themselves.

To avoid this problem, Foray (2015) proposes to stimulate the entrepreneurial discovery process at both regional and national level. He defines the entrepreneurial discoverer as a cooperation between a public sector agency (the smart specialization program), entrepreneurs and scientists. Here, the public sector actor use the smart specialization strategy to support innovations which may fit into the economy. Crucially, the public sector takes the risk and in that way removes the failure trap.

EDP provides a new definition of the entrepreneur. Entrepreneurial discovery is *what regional policy makers and developers should do together with business world and universities*. (Foray & Rinoldi, 2013). This is a new set of roles, where we have a collaborative triple helix set of entrepreneurial actors, economy, science and government. The entrepreneur is the collective of triple helix actors. Through a collective process of self-discovery, the partners of these institutional spheres are supposed to open up an economy with a bias towards exploitation to exploration.

Figure 10. The collective entrepreneur in EDP (Source: Virkkala et al, 2017)



The collective entrepreneur in figures 10 comes from universities, firms and the public sector.

b. Complexity and EDP

The "discovery" in EDP is not an innovation, but an opening of a new area of business opportunities. This area is related to and builds on existing knowledge and industrial resources (combined with external) and it opens up a new, emerging path of development. Based on this dynamic theory of growth, smart specialisation strategies coordinate search for new business areas. It is explorative rather than exploitative. As we will see below, this has clear policy implications when it comes to public sector involvement. Incentives should only be provided to "new" activities (Morgan, 2017, p. 51). The strategy aims to seize new opportunities over time and progressively create new options for economic transformation; therefore, regional policy should regularly change the portfolio of prioritized activities (Foray, 2015). This opens the question of how to balance the tension between changing priorities and policy continuity (Morgan, 2017; Grillo, 2017).

EDP creates a new possibility to move beyond the limitations of the national economic structure and integrate distant forms of knowledge. Relevant knowledge for the selection to the new business domain may be dispersed, decentralized, divided and possessed by various entrepreneurial agents like firms, universities, knowledge brokers, independent inventors and lead users. In Norway, such knowledge is embedded in the logic of exploitation. It has to be made available for exploration.

Nobody has perfect information on new business areas and future possibilities and developments, and the idea of EDP is that awareness and acceptance of new business opportunities is emerging in an inclusive partnership consisting of public and private actors, but the entrepreneurial actors are the most important. That is the reason dialogue, negotiation and local experimentation are central in the smart specialization. A policy should be seen as an emergent dynamic phenomenon of creating and gradually modifying a joint understanding of the what, why and how of certain public activities in an on-going communication process. Based mainly on trial and error, this process, at the same time, reflects past results, monitor on-going activities and develops new perspectives for future activities. (Morgan, 2017)

2.2.4 CONNECTING MACRO AND MICRO

Economic restructuring process, in our approach, is diversifying the economy in the direction of complexity by investing in R&D with the support of science and innovation policy. In their theory of economic complexity, which has the central role in economic growth and development, Hidalgo and Hausmann (2009) refer to capabilities as building block for the economic complexity. Capabilities, in this sense, are the inputs for producing a product a country exports. Felipe et al. (2012) summarize these capabilities as the composition of:

> "(i) the set of human and physical capital, the legal system, institutions, etc. that are needed to produce a product (hence, they are product-specific, not just a set of amorphous factor inputs); (ii) at the firm level, they are the "know-how" or working practices held collectively by the group of individuals comprising the firm; and (iii) the organizational abilities that provide the capacity to form, manage, and operate activities that involve large numbers of people." (Felipe et al., 2012)

An important take-away from this perspective is that capabilities are created by combination of innovation system (macro level), i.e. "the set of human and physical capital, the legal system, institutions, etc. that are needed to produce a product", and innovation firms (micro level). Therefore, in the process of structural transformation, connecting macro and micro level for acquiring capabilities for exploiting, exploring, and balancing has the central role for the success of restructuring. This success requires a better coordination between the micro (innovation firms) and macro (innovation policy/ system) level, opening a stronger emphasis of exploration through partnerships between public policy makers, and entrepreneurs who knows the market, and researchers, backing up by appropriate science and innovation policies. These policies need to originate from a thorough understanding of role and challenge of both macro and micro level in order to create successful economic restructuring through joint entrepreneurial discoveries.

Exploration from the point of departure of a single corporate actor may be restricted by the limitations of the corporate knowledge base (the competency trap) and it might start to crowd out exploration, leading to failure. In the theory of smart specialisation and EDP (Foray, 2015), exploration is externalized, and carried on by the powerful wings of science. Through a strategy coordinated by public sector, universities, and industry, exploration process may escape from the narrow borders of corporate knowledge bases and national economic structures. This will help grow cross-sector collaboration, cross-disciplinary and transnational platforms of innovation. A crucial issue is connecting the logic of public sector operators (macro) and the world seen from inside firms (micro) to balance exploration and exploitation.

Our scoping paper will look into this and try to understand how to connect these two levels successfully by science and innovation policies for the sake of economic growth.

3 METHODOLOGY

The entrepreneurial discovery process is not a static model of a fixed region. Because it is based on economics, and not geography, it is applicable as a way of understanding processes in different geographies, either in a locality, a region (Mariussen & Vinogradov, 2016; Mariussen, Finne & Ljunggren, 2016), or at the national level, or at a "macro regional" level, like the North Sea region (Mariussen, Ruslan & Lina 2016). Innovation systems and networks in Norway are often "multi-level". Parts of Norway has "thick" regional innovation systems, in other part of the country these are different types of geography. Important Norwegian clusters, like petroleum and salmon, have national systems of innovation. The project will take these complex, multi-level specific characteristics into consideration of the research design.

3.1 RESEARCH DESIGN

Understanding the nature of multi-level characteristic and the need to connect micro and macro level of analysis, we employ mixed method to approach this challenge. The value of mixed method research has been documented in literature (Gibson, 2017), including "elaboration, generalization, triangulation, and interpretation" (p. 193). Our research design aims to triangulate literatures from innovation system and policy with organizational innovation in order to elaborate ad generalize the mechanisms for connecting micro level (organizational innovation) and macro level (innovation system and policy) for economic restructuring.

At micro level, we use interview data from innovation firms, using theory of organizational innovation to build interview guidelines. We choose firms that are innovation leaders in different sectors in Norway because they have deep understandings about their own business in the current situation of Norway and the challenges for coordinating micro and macro level.

At macro level, we use panel data from The Atlas of Economic Complexity database (2016) and Frascati Manual data of GERD from 2016 to analyze economic growth of a variety of countries. We test the theory of diversification (Rodrik, 2004) and complexity (Hausmann, Hildago et al., 2014) with these empirical data, then identify outliers and look for explanation. The results help us understand the mechanism for economic growth in Norway.

After analyzing results from the preliminary data, we organize a dialogue meeting between triple-helix actors (policy-makers, researchers, and industry firms) to present our findings and ask for their input. Finally, we consolidate all data and information to analyze and write this scoping paper.

More details are elaborated in the description of work packages

3.2 DESCRIPTION OF WORK PACKGES (WP)

Table 2: BEECO Work Package structure

Work packages	Methods	Outputs (RQ)	Literature theme
WP1: Micro level Mechanisms to strengthen and balance exploration and exploitation simultaneously & the interconnection with macro level.	Exploratory micro level case studies	- Understand the mechanism used for strengthening and managing exploration and exploitation simultaneously by entrepreneurial actors (innovative firms). - Examine which kinds of support these actors need from policies and what they contribute to economic restructuring.	Ambidexterity, dynamic capabilities, absorptive capacity, innovation value chain.
WP2: Macro level Mechanisms for economic restructuring and growth	Desk top study of macro level indicators (GERD, complexiy, GDP/capita)	- Understand the mechanism used for economic restructuring - Examine which information policymakers need from entrepreneurial actors to solve their policy design challenges.	Smart specialisation strategy, triple helix, diversification and complexity.
WP3: Analysis Co-evolution of policies, industries and R&D institutions for economic restructuring	Combination of empirical data analysis and theoretical framework from several streams of research in extant literature of organizational theory and innovation system and policy.	- Build an analytical framework for joining efforts between policymakers and innovation actors to co-design strategy for successful economic restructuring.	Combination of literature themes from micro and macro level.
WP4: Dialogue between levels Co-evolution of triple helices.	Focus group meeting with triple helix actors	- Knowledge sharing within each level and across levels. - Collective learning within and across level. - Co-design strategy for successful economic restructuring.	

3.2.1 WP1: MECHANISMS AT THE MICRO LEVEL

The objective of WP1 is to understand the operative mechanisms at micro level activities and examine the interconnection with macro level activities. The operative mechanisms of entrepreneurial actors include mechanisms to strengthen exploitation and exploration together with mechanisms to balance the tensions between these two conflicting yet complementary activities (March, 1991; Tushman & O' Reilly, 1996; Lavie et al., 2010; Turner et al., 2013). At the same time, we seek to understand which kinds of support entrepreneurial actors need from regional/national policies and what they contribute to the economic restructuring process. This will be greatly beneficial to RIS policy and research since they can understand better "the extent

to which local innovation is associated with regional economic growth" (Isaksen & Jacobsen, 2017, p.385) and what they can do to support such activities.

Methodologically, our research design is exploratory case studies including four steps:

(1) Selection of entrepreneurial actors: We choose to interview innovation leaders, which are big corporations affecting from the current change in economic environment, and are persistently working towards new direction for restructuring and growth by using innovation.

(2) Data collection in the forms of semi-structured interviews with top management team in selected companies (in oil and gas sector, maritime sector, chemical sector, mechanical and electro-technical sector). The research team also went to conferences which include companies in multi-sectors, seminars which include triple helix actors.

Table 3. Interview data collection

Interviews / Seminars	Quantity
Oil and gas sector	1 interview x 45 minutes
Maritime	2 interviews x 60 minutes /each
Mechanical & electro-technical	1 interview x 60 minutes
Chemicals sector	2 interviews x 45 minutes / each
Multi-sectors	1 conference
Seminars (workshop & dialogue included)	4 seminars

Questions for the semi-structured interviews include "Can you please tell us a little bit about your company's innovation strategy?", "What are the challenges internally and externally, especially in terms of policy?", "What would you recommend future policies would be to facilitate your innovation strategy?".

(3) Data analysis based on multiple iterations between data and theory (Eisenhardt, 1989). This can lead to additional data collection to clarify our understanding after analysing initial data.

(4) Results and synthesis of findings to answer our research question and fulfil the objectives of WP1.

WP 1 aims to (1) elaborate the mechanisms which entrepreneurial actors employ to strengthen their exploration and exploitation capabilities, as well as the ambidexterity mechanism they use to balance the tensions between these two paradoxical activities; (2) explain the interconnection between micro level activities and macro level activities, especially what kinds of benefit they contribute to regional growth and what kinds of support they need from regional policies. This provides input to WP2 and WP3.

3.2.2 WP2: MECHANISMS AT THE MACRO LEVEL

The objective of WP 2 is to understand in what ways the macro level influences the balance between exploration and exploitation in the Norwegian economy.

At the macro level, there is a tension between smart specialization strategies supporting exploration and cluster and other strategies supporting path maintenance. This tension plays out in the context of multi-level R&I governance systems (transnational - national – regional), in triple helix relations, as well as in the evolution of entrepreneurial ecosystems (Borrisenko et al., 2016), where the outputs of the macro level "meet" micro level entrepreneurial strategies. It has impacts on the dynamics of innovation and structural economic transformation (Foray, 2015) and accordingly on the balance between exploration and exploitation. Relevant strategies of coordination are inclusive planning processes informed by structural economic analysis (Rodrik 2014; Foray, 2015; Gianelle et al., 2016), triple helix coordination (Virkkala et al. 2017), public-private co-evolution (Sabel et al., 2017) and RIS coordination.

Methodologically. WP 2 compared Norway to 22 other OECD-related countries based on Frascati – manual statistics as well as complexity indicators provided by data from the 122 countries covered by the Atlas of Economic Complexity. This helped to identify the position of the knowledge domains supporting the global market competitiveness of the Norwegian economy. Based on this, WP 2 contributed to the development of the economic restructuring conceptual framework which conceptually connects macro level indicators with an analysis of dynamic capabilities. This provided indications for future strategies, given the Norwegian point of departure.

WP2 explains the role of the macro level, in creating the context of the micro level actors confronted with challenges of restructuring.
WP 1 and WP2 provide input for WP 3 and WP 4.

3.2.3 WP3: ANALYTICAL CONCEPTUAL FRAMEWORK

Objective. ***Develop an analytical framework for understanding co-evolution between policies, industries and R&D institutions for economic restructuring***. Proceeding from the concept of entrepreneurial ecosystem, and taking into consideration outputs from WP 1 and 2, WP 3 will develop an analytical conceptual framework for co-evolution of policies (macro level) and industrial strategies (micro level). Co-evolution mean that the two levels are adjusting to each other's development through time (Lewin, Long and Caroll, 1999).

Method. Combination of empirical data analysis and theoretical framework from several streams of research in existing literature.

WP 3 is expected to open up the way how to connect micro and macro level. This is done through building an analytical framework for joining efforts between policymakers and innovation actors to co-design strategy for successful economic restructuring. The framework will be tested through dialogue among actors in Work Package 4.

3.2.4 WP4: DIALOGUE BETWEEN TRIPLE-HELIX ACTORS

Objective. By testing and developing the findings from WP 1, 2 and 3 through dialogue between triple helix actors, this work package will synthesize knowledge of theory and empirical data in order to propose a strategy for further research on methods for designing successful economic restructuring in Norway.

Method. One focus group meeting in cooperation with the Norwegian Research Council with core informants from the firms and public sector will be presented for the results of the analysis in WP 1, WP 2 and WP 3. The focus group dialogue is expected to clarify the tacit knowledge (Nonaka, 1994) of co-evolution, and in that test the findings from the analysis, and add additional factors with relevance for the conclusions.

Participants: There are three categories of participants (triple-helix approach) in the focus group meeting:
- Policy-makers: can be at national or regional level.
- Top management team member at case companies.
- Researchers conducting this project and scholars who are researching on the same topic.

Expected outputs are knowledge sharing within each level and across levels, collective learning within and across level as well as suggestions for co-design of strategies for successful economic restructuring.

The dialogue was organized on 27 November 2017 at the Research Council of Norway with 13 participants (3 joined via video-conference)

4 ANALYSIS AND RESULTS

4.1 MICRO LEVEL PERSPECTIVE

Data collected in WP1 was analyzed according to three main themes:
1. Innovation strategy of firms in the time of uncertainty
2. Challenges they are facing internally (how to innovate inside organizations), and externally (how to collaborate strategically with innovation policies in Norway).
3. Suggestion and recommendation for Norwegian innovation policies.

We present the results of the first two themes in the section 4.1, and the result for the third theme in section 4.3.

4.1.1 INNOVATION STRATEGY IN THE TIME OF UNCERTAINTY

We summarize results from the interview with innovation firms when it comes to their innovation strategy in the context of turbulence in table 4 below.

Table 4. Innovation strategy at firm level

INNOVATION STRATEGY AT FIRM LEVEL
1) Direction for the future: - Focus on sustainability: Pay attention to environment, climate changes, circular economy, renewables, low carbon, CO2 footprint - New business sectors: renewable energy, ocean, marine leisure - New technologies: automation, digitalization, software integration - New business model innovations - Beware of disruptive innovations - Success factors: Innovation champions (especially CEO & Top Management Team), multi-disciplinary collaboration
2) Exploitation strategy: - Secure the current competitiveness and continue improving efficiency - Focus on the core competence and core customers, exploit daily operation - Enhance productivity and create standard knowledge for productivity system
3) Exploration strategy: - Establish autonomous unit focusing on new ideas and new solutions - Key exploration activities focused on long term based on strategic direction - Technological and knowledge cooperation with universities and research institutes - Internal R&D for sensitive and secret technologies - Explore across sectors - Look at different methodologies for current tasks
4) Balancing (explore and exploit) strategy: - Implement two activities in parallel but organize different approaches and incentives for them. - Coordinate and integrate two activities: connect and liaise various parts of the R&D so that works can be hand-offs properly. - Create innovation platforms for running various innovation projects - Disseminate management practices of successful innovations to the rest of the organization.
5) Diversification strategy: - Diversify within the company. - Diversify along the value chains. - Diversify to completely new areas.

4.1.2 CHALLENGES

The challenges which innovation firms are facing divide into two sources: internally and externally. Internal challenges refer to firms' own difficulty when implementing their innovations strategy, while external challenges refer to difficulty when conforming to national policies. The result is summarized in table 5 below.

Table 5. Challenges of innovation actors

INTERNAL CHALLENGES (from self-organizing)
- Lack of investments and preconditions for digitalizing in a large scale. - Huge investments for risky business. - Need to come up with new business model. - Intermittency is one of the biggest challenges in production. - Need to update knowledge continuously in daily business. - Big challenges come from human resources: first generation of oil workers are now facing retirement, lack of skill from next generation. Less students interested in energy business now - Renewable industry is fragmented and less profitable than O&G. - Moving competences and resources from one division to another one is not that simple, the business model needs to be adapted: "*Do you recognize this fact that yes, its skills can be applied in other industries, et cetera, but how do you make value? How do you make money, both in the short and the longer term? These organizational business models, how do you ... What do you do? What are your main challenges in that*?" - Creating synergies between various disciplines when the company becomes very big: "*It's about creating synergies between various disciplines inside organization. Actually to understand what they know is a challenge in itself when you become very big. In the industry we have about 70 to 80 different technical disciplines that need to interact which are rooted in 16 different capability clusters, they all have to be orchestrated so they maximize the benefits from everybody in a way. I think actually there is an organization challenge to make sure that you take advantage of what everybody knows and break down the silos*"
EXTERNAL CHALLENGES (from policies & system)
- Carbon Capture Storage (CCS) is a driven concept in Norway, but does not help green change due to substantial cost / investment and "too expensive". - "*At national level, policies focus too much on exploitation of the existing, which is oil and gas, and not looking at exploring other alternative things. And the one thing impedes the other*". Stop subsidizing and favoring the oil industry will make politicians "*extremely unpopular since they have to do some tremendous changes, which will be extremely painful in the short term.*" - Research Council and Innovation Norway funding system is "extremely unequal": Whereas Research Council "*sits on a huge pile of money, but very limited in what they can fund, Innovation Norway has a very small pocket and has basically not that much they can fund*". - Norwegian model has underestimated the industry when following typical route of research and technology development, at least such core technology, within academic centers like NTNU and SINTEF. "*Industry moves incredibly fast*", "*NTNU, SINTEF and others are very skilled but they do not have a chance to keep up with the developments here in industry. They also focus on researching topics that give them points in journal articles and what can be measured academically, but not necessarily important for business and industry in Norway.*" - Norwegian political picture: "*It's more politically correct to give a little bit too many than give a little bit more to a few, but the latter is important and effective for developing industries. It's about focus, choosing the right programs to support."*

The results from firms' innovation strategy and internal challenges have illustrated the problem of balancing exploitation and exploration activities at organizational level.

Exploitation refers to activities focus on the current existing strength / competitive advantage of the economy, while ***exploration*** refers to activities for developing new knowledge domains which will become the next competitive advantage in the future:

> "Exploitation is about efficiency, increasing productivity, control, certainty, and variance reduction. Exploration is about search, discovery, autonomy, innovation and embracing variation" (O'Reilly & Tushman, 2008, p. 189)

Exploitation is more attractive, profitable in short-term, and much less risky than exploration, therefore, much easier to be implemented. Exploration is quite on the contrary: risky, uncertain, and long-term investment, thus it is normally ignored. If there is no action to balance these two activities, exploitation will crowd out exploration (March, 1991). As a consequence, firms with strong exploitation capabilities will suffer from innovation dilemma (Christensen, 1997) and will fail when new entrants come up with disruptive innovation; or countries with strong natural resource will suffer from the resource curse (Ross, 1999) and Dutch disease (Torvik, 2001), and experience slower or poorer economic and political development. This phenomenon can be referred to as "lock-in trap" or "competence trap" (Levinthal & March, 1993).

To avoid this lock-in trap, balancing between exploration and exploitation is the key element. This requires ***dynamic capability***, which is the ability "to maintain ecological fitness and, when necessary, to reconfigure existing assets and develop the new skills needed to address emerging threats and opportunities" (O'Reilly & Tushman, 2008). This is the capability to help innovation actors to balance the exploitation and exploration activities by reallocate existing resources and acquiring new skills that will be potential useful for the future. At firm level (micro level), this dynamic capability is also called as ambidexterity (O'Reilly & Tushman, 2008). The tension between exploration and exploitation is fundamental and inherent which cannot be solved for good. Focusing on either one will lead to ultimate failure. To survive in the long term, it is essential to maintain the balance between them, and rebalance when the environment changes.

Meanwhile, the result from firms' external challenge becomes the input for WP2, which is analyzing the macro level, national system and innovation policies.

4.2 MACRO PERSPECTIVE:

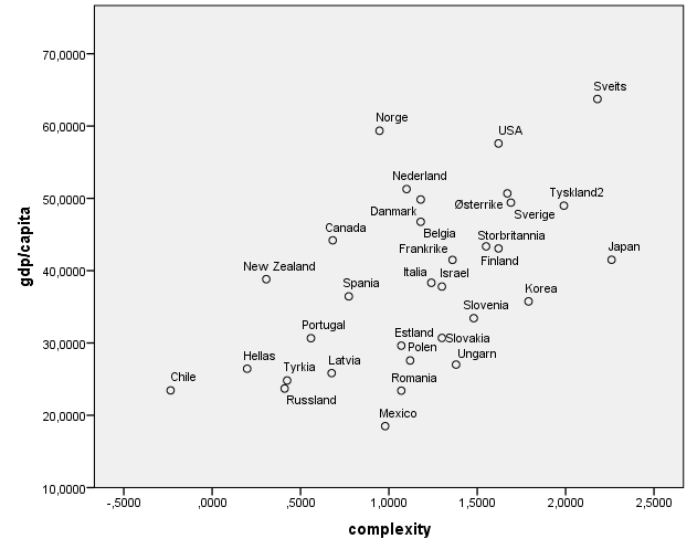
In our theoretical reference frames, there are two models to explain economic growth:
- Country complexity (exhibited in terms of ECI) contributes to future economic growth. This is the main argument of complexity theory.
- R&D investment (exhibited in terms of GERD indicators) contribute to future economic growth.
We use data on national GDP, ECI, and GERD to examine these models in order to understand which model can be used for Norway.

4.2.1 COMPLEXITY MODEL

4.2.1.1 Complexity and GDP

Countries grow in many different ways through processes of specialization, restructuring, crises and transformation. GDP/ capita may go up and down due to a number of reasons, such as changing fortunes when it comes to prices of core export products, currency fluctuations and policies. With reference to Rodrik and Foray/ Smart Specialization, we pointed out that two distinct and related processes are smart specialization, which may build on domains providing competitive advantages, followed by creation of new industrial sectors, through various forms of innovation based on related varieties and entrepreneurial self-discoveries. This model of Rodrik, the combined process of specialization and diversification may explain static patterns, and it may be seen as an explanation of growth. Above we have argued that the Hausmann ECI or country complexity index may be seen as a measure of diversification. The figure below shows a static picture, the relation between the Hausman ECI scores of 32 OECD related countries for 2016 and GDP/ capita for 2016. We have chosen these 32 countries because we also have International R&D Statistics provided by the OECD, in addition to data from the Atlas of Economic Complexity.

Figure 11. Correlation between GDP and ECI



In figure 11, the correlation between GDP and complexity (ECI) is **+0,563**. This static picture may be seen as the frozen result of a long historical development, a snapshot of a dynamic process going on in all 32 countries.

This static snapshot is consistent with a dynamic theory that complexity drives growth. Countries which manage to diversify through entrepreneurial discoveries and create new industries climb in the complexity indicator, and this gives them a growth impulse. In a static way, the picture also confirms what we know from the Atlas, that the evolution of complexity tends to result in a center – periphery pattern in the global economy, where some countries like Switzerland, specialize in a high level of complexity, and some, like Chile, depend on extraction of raw material which suck in national resources and undermine diversification. Chile used to have a more complex economy, with refined copper products. Recently, the country has enjoyed a rapid increase in export of copper ore in large quantities to China. Countries like Switzerland has several highly specialized sectors which produce complex products, which may be used in

different ways inside different sectors. The co-location of many complex products within one economy leads to a self-reinforcing process, with many horizontal networks between deep and highly specialized value chains. One of the core export articles from Switzerland is gold, not gold ore, but as refined and well-paid jewelry. In order to make their jewels, Swiss goldsmiths need sophisticated tools. The development of these tools drives other parts of their economy.

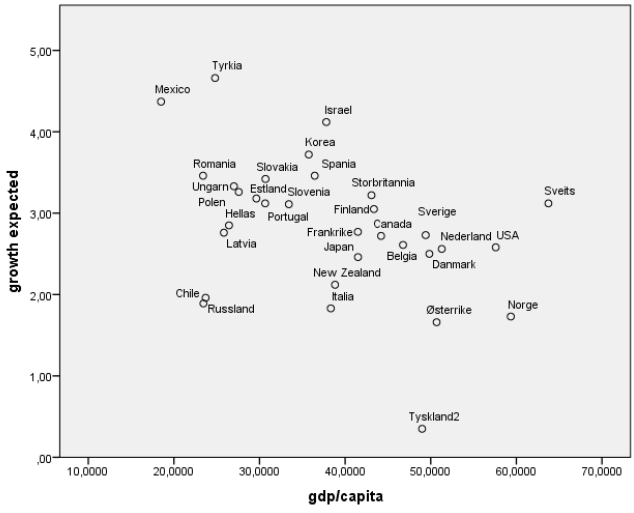
This figure 11 also illustrates the outliers. On one side there are countries with "too much" GDP/ capita because they are enjoy exploiting natural resources (New Zeeland, Canada, Denmark, Nederland and Norway). On the other side there are countries which enjoy medium high levels of complexity and yet has fairly low GDP/ capita. That is Eastern European countries like Romania, Poland, Slovakia, Hungary and Estonia.

4.2.1.2 Using complexity theory to explain expected growth

The Atlas of Economic Complexity is making growth forecasts. Growth expectancy are based on distances to new products from the current export basket of 122 countries. It is based on a strategy of diversification where countries prefer "easy" targets, or new products which are most closely related to already existing products in the export basket.

The country with highest growth expectancy is India, with 6,98%. Norway is number 110 (of 120 countries), with a growth expectancy of 1,73. Using this data (growth expectancy) to match with country economic performance (GDP/capita), we get the following result:

Figure 12. Correlation of expected growth (based on complexity theory) and economic performance (GDP)



The correlation between GDP/capita and expected growth is **-0,428**. Using complexity to predict expected growth, figure 12 show the winners are Turkey and Mexico. Countries with the least expected growth is Germany, Norway, and Austria.

The conclusion is that complexity theory can only explain growth for emerging countries, not developed countries. Emerging countries are in rapid processes of industrialization, and the potential for innovation through related varieties, or discovery of products which is related to the basket of already existing export products is large. This is why Turkey and Mexico stay on top of the expected growth list. Complexity might be seen as a strategy for growth in emerging

economies, where the R&D institutions are weakly connected to firms. The result is consistent with global theories of convergence.

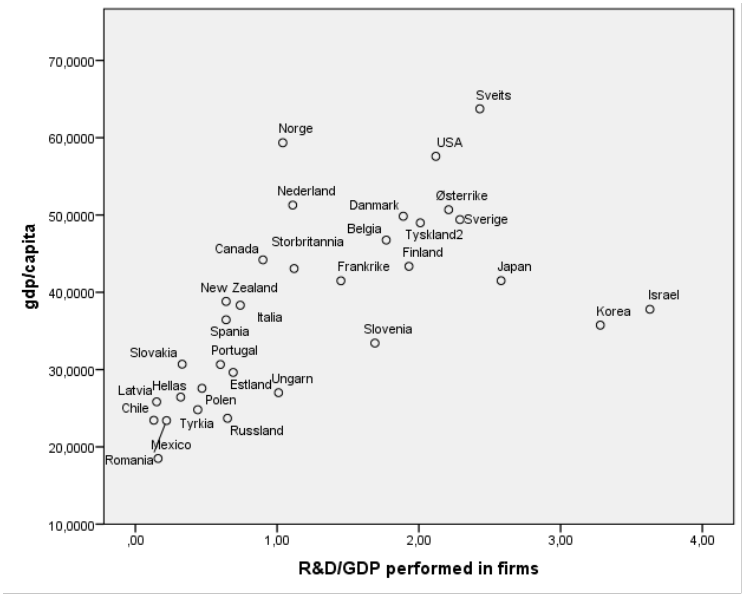
The complexity model of Hausmann shows the growth potential of "emerging" economies, and it shows how the growth potential of advanced economies would have looked like without science to back up innovation. For example, Germany is a developed country where the "easy" strategy of innovation through related variety/self-discovery **without a science and innovation component** is exhausted. Therefore, if Germany depends only on increasing country complexity without investing in R&D, their expected growth is extremely low as shown in figure 12. This is consistent with the idea that the complexity model of growth on its own, without the assistance of science and innovation is driving convergence in the global economy. In emerging economies, like Mexico and Turkey, innovation through related varieties may go on without R&D policies.

The growth strategy in advanced economies cannot be explained by using complexity model alone. Developed countries need more science input to grow. We will look at the second model of growth (R&D investment) in the next part.

4.2.2 R&D INVESTMENT MODEL OF GROWH

To what extent does high levels of R&D carried out in firms lead to growth? Figure 13 below shows the level of GDP/capita carried out in firms and GDP/ capita 2016.

Figure 13. Correlation between GDP and GERD



The correlation between GDP and GERD is **+0.600**. A correlation of +1 would mean that R&D performed in firms would determine GDP/capita. A correlation of 0 would mean that there is no connection between these factors. 0.6 means that there is a strong relation, but that there are also other factors influencing GDP/ capita, such as exploitation of natural resources. 0.6 indicates that countries with companies who invest heavily and wisely in R&D are likely to grow, whereas countries like Rumania with small R&D activities in firms are not likely to grow.

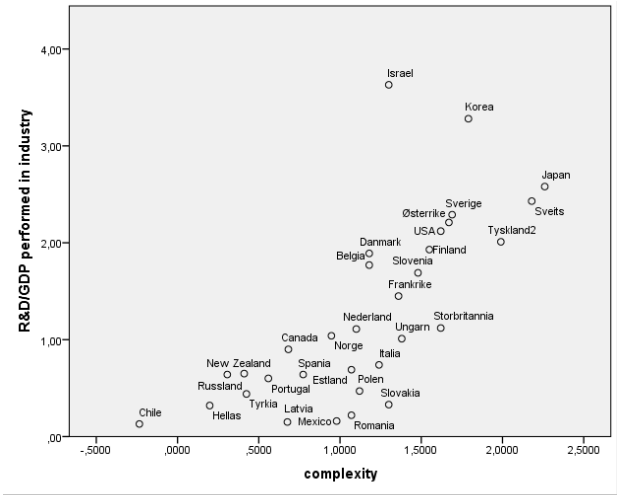
The outliers are on one hand Norway, with “too much” GDP/capita in relation to R&D performed in firms, and on the other side Korea and Israel, two countries where several globally leading corporations invest heavily in R&D. The figure illustrates that if Norway did not have advantages due to natural resources, the country would either be much poorer, or it should develop a more advanced system of innovation.

So here we obviously have two different models of growth, growth through complexity and growth through R&D carried out in firms, yet none of them explain the case of Norway. How are these two dynamics related to each other, and how can the case of Norway be explained?

4.2.3 COMBINING TWO MODELS: COMPLEXITY AND R&D INVESTMENT

In the theory part, we have shown that countries with high complexity tend to have high R&D investment from industry. Figure 14 helps us examine the relationship between these two indicators.

Figure 14. Correlation between GERD in industry and ECI



The correlation between complexity and R&D performed inside firms is **+0,862**. Israel and Korea are outliers with massive R&D investments in firms seen in relation to the level of complexity of their national economies due to their military activities.

In this figure, Norway is no longer an outlier, it fits nicely in together with other advanced processors of natural resources, such as Canada and Netherlands. It seems that Norway has a level of R&D performed in firms which fits pretty well with the level of complexity.

The analysis has shown that the Rodrik story of complexity and the science and innovation policy story of growth driven by R&D investments inside firms are complimentary. They are reinforcing each other. This is the basis that Forays apply the Rodrik model of growth together with science policy regarding R&D investments in Smart Specialization.

It indicates that increased complexity, or innovation through related varieties, does require increased R&D inside firms, and the other way around. **This combination of the two models of growth is precisely what policies promoting smart specialization is designed to deliver**.

An intuitive explanation is that firms with complex products operating inside complex economies use science to a larger extent than firms with less complex products in less complex economies. It seems as though in order to diversify at a higher and higher level of diversification, you need more and more science inside firms. Complex products made for even more complex products, like car or computer components, have to be tested and documented, using laboratories and scientific tools of measurement. If they are to be improved or reinvented, the process of innovation is likely to go through R&D. To put this differently, the scope of what is related within a complex economy is broader than in a less complex economy. The combination of innovation through related varieties and science policies promoting innovation is at the core of the Smart Specialisation strategy.

4.2.4 MAPPING PATHS TO GROWTH

The above analysis shows that there are two sources of wealth: R&D intensive complexity and R&D intensive exploitation of natural resources.

1. Countries may achieve high levels of GDP/capita through high levels of complexity (diversification), combined with large R&D investments made inside firms and by the public sector in universities, in some cases in synergy with each other. Examples are Switzerland, Germany, USA, Austria, Japan, Korea, Sweden, Finland and others.
2. Countries may have moderate firm R&D investments and nevertheless enjoy incomes from advanced and highly productive export industries based on natural resources, supported by strong science based sectoral systems of innovation. Examples are Norway, Netherlands, Denmark, New Zealand and Australia

These sources of growth may sometimes be successfully combined, when countries manage to use strengths in their resource-based systems of innovation to diversify and grow new export industries. They may also be conflicting, such as in cases where the resource-based clusters are outcompeting other sectors in the labor market, driving out growth and lock supplier industries, such as mechanical industries, into golden cages of well-paid sophisticated products which are remote from other sectors. At the same time too well-paid raw materials may create labor markets which excludes several manufacturing sectors relying of labor intensive work and lock the surviving sectors into strategies of increasing capital intensity and deep specialization, away from diversification.

4.3 CONNECTING MICRO AND MACRO IN NORWEGIAN CONTEXT

The analysis from WP1 and WP2 combined helps us come up with these results:
- Micro level, i.e. innovation firms, has moved very fast in technology development and innovation strategies because they have to cope directly with the rapid change in business environment.
- Macro level, i.e. innovation policies, needs to combine both complexity theory and R&D investment in industry guided by science to create economic growth.
- To solve the challenges from internal and external of innovation actors, innovation system and policies need to come up with a strategy for connecting micro and macro level.

Data collected from the interview with innovation firms, from triple helix dialogue and workshop has provided us table 6 summarizing recommendations for connecting micro and macro.

Table 6. Suggestions for connecting micro and macro

SUGGESTIONS FOR CONNECTING MICRO AND MACRO
<u>1) Strengthen the core</u> **** Build on existing:*** - We should not build from scratch but build on what we have done well: "*There is so much competence can be transferred from oil and gas to build new expertise, to reduce cost and improve the current concept*" - We need to develop sustainable solutions for both O&G and renewables with optimism and self-confident to build on what we have. "*There are so many opportunities there if we just match technology with the right business model and don't only go for the past*". - Norwegian way (strong support from Norwegian society and community, flat structure, less hierarchy structure) has worked well so far. **** 3 important conditions for current petroleum sector:*** - Stable and predictable framework: The petroleum industry is financial cyclic, it's very important for government to provide stability. "*Close interaction and dialogue between different players and parties in the ecosystem is an important way for the authorities to pick up and analyze and see what changes need to be made*". - Support efforts of industry to expand internationally since M&A globally helps facilitate transfer competence and create synergies between O&G and renewables. - Increase competence in R&D: by facilitating the collaboration between companies, R&D institutes and universities to solve the challenge.
<u>2) Explore the new:</u> **** Offer incentives for industry players to transform themselves:*** - "*You can't support them. You can't merger them. You can't babysit for them. You have to give good incentives and I don't know what these incentives should be. That's the very important part, I think, and what to make a policy for the future also in order to enter from the fossil area into the renewable area*" - "*Why don't they start moving much more forward to looking at how can we make efficient sort of green banks. How can it do efficient grid? How can it do green energy? To look into that one. Because I believe that if you look at the cost of offshore wind, onshore wind, solar energy and stuff like that, it is rapidly decreasing, and the only way to get it decreasing even further is to continue to push it. And for me that is much more of a fundamental change than CCS which is basically, for me it's an excuse to continue to pump oil and gas and then try to capture the CO2 going out*"
<u>3) Diversification cross-sectors:</u> **** Joint university and industry, create network and hubs for knowledge transfer:*** - "*So knowledge transfer, both within their own company, but also across the own and other companies is very important to us*", - "*Perhaps we can create consortium and cooperation between the companies to force a bit like co-location"*

- *"It has very much with chemistry to do. … those who are in NFR they must get out and actually get to know and in a way to develop a more personal relationship like that. I think that they are good at. We've got this world conference ... we have cluster conference here, where is everybody, we have the world conference, coming in November, where all of these agencies and are on the ball and get to know both issues and people know people by face. It is very important. So that these officers if you will, the employees of the Research Council and Innovation Norway come out and get involved in a way becomes part of the environment, it is something I consider essential. It is quite another to call a person you have met and talked a little with and you know how act etc., You know where he needs to be a bit bureaucratic and when he can in a way help you a little extra. It is essential. And it's very hard to get to the phone without having sat maybe and even taken a beer together and chatted a bit"*

**** Invest more in industry so that they can do R&D inside the firms:***

- *"I think instead of routing through research and universities, I think I would have routed it through industry, and so the industry has bought services, that is, it has been done in the way that it would be beneficial to buy services from NTNU and SINTEF, but did not necessarily check the cash through NTNU and SINTEF, if you understand. It's like the one who sits on the cash flow and defines the programs etc., it in a way sets the limits here. And I think the industry would have done much more efficiently. And then one had taken these research organizations. We do not have a chance in the ocean to do all this on our own, it will be quite natural to put away much of the work for NTNU and others. And if in one way they had stimuli in the programs and the way they are defined, then maybe one could have gained extra points for it in terms of whether or not winning a funding triggered, so I think one could have done a lot like that"*

**** Massive investments on digitalization are needed:***

- *"One thing is very important, which I see everywhere, is that digital solutions are implemented in large scale. Implementing digital solutions is really a game changer. Today we see the PlayStation generation is taking over. It is very attractive to younger people with high IT capabilities to actually take part in our industry*"
- *"I think that the way to succeed is a bit like this, when you set up this NOVA Fund, which was meant to look at how to bring new technology in environmental technology and energy efficiency. I think we should have had something similar in Norway about digitalization, and make it across industry so that digitalization can be in healthcare, school and maritime industries and other industries, transport, etc. For that we need, such a national venture around digitization that I feel in a way is not entirely in place. And then that's how it's going to be done. I think in a way, it's a bit too difficult today because the Norwegian Research Council really puts the key and is both in structure and experience on how to handle these things. It's more about somehow a political will I think in a way to create a huge program called digitalization and then use one then the tools that are already in relation to the fact that the Research Council typically will in a way treat that type applications. So there are enough things to do if one really is to succeed and make this happen.*"

**** Regulation should co-evolve with industry:***

- The regulatory and safety system need to consider how to incorporate innovation into the system and change the system accordingly with the increase in innovation. *"Digitalization is one very important example. How to deal with digitalization and also keep the safety levels as high as possible*."

**** Maintain the good balance:***
-"*For innovation, it's important to have good balance between different stakeholders. These stakeholders in our industry are Norwegians, versus non-Norwegians. We can see all our companies are becoming very international. The staff is consisting of people from everywhere. China, Brazil, US, Norway working together. I think there is a good balance between young and older employees. I think this good balance maybe not as good as we had hoped between gender. It's less women enrolled in the oil industry, actually, than in many other industries, but I know it's high on the agenda for companies to have equal opportunity for all genders. I think also in Norway, typically, there's a good balance between the owners and the trade unions. I think that's really an important attribute of the Norwegian industry that one is able to work together and there's a certain security in terms of employment here in Norway, so that is also part very important for innovation*."
**** Create a holistic approach for innovation policies, especially holistic knowledge center:***
Connecting different industries, developing skills, learning transnational (especially Singapore, a country without natural resources but high GDP), long-term planning, multi-disciplinary and inter-segment across industries.

5 MAIN FINDINGS

In the analysis and result section, we conclude that there are different paths to economic growth. Emerging economies may grow through related varieties, independent of institutional frameworks. Countries with low levels of GDP/capita, low levels of R&D investments and a moderate level of complexity may enjoy a potential of growth through innovation through related varieties. Examples where entrepreneurial discoveries may be expected to give results without a pro-active science policy are India, Turkey and Mexico. But Norway is different. Instead, the institutional challenges of Norway, such as sectorization, lack of horizontal networks, and sectoral systems of innovation (OECD, 2016), limit the potential for "easy" innovation through related varieties. In overcoming these challenges, there is a need to upgrade knowledge domains supporting new industries through innovation platforms supporting entrepreneurial discovery processes and the development of cross sector innovation networks.

The need for policy intervention is also caused by the firm structure. Some countries, like Korea and Japan, have been able to develop highly complex economies through processes of diversification and self-discovery driven by large corporate actors with massive R&D investments. However, Norway has a micro level of firms and clusters which is very different from Japan and Korea. Therefore, Norway needs a different strategy for growth, which will be elaborated below.

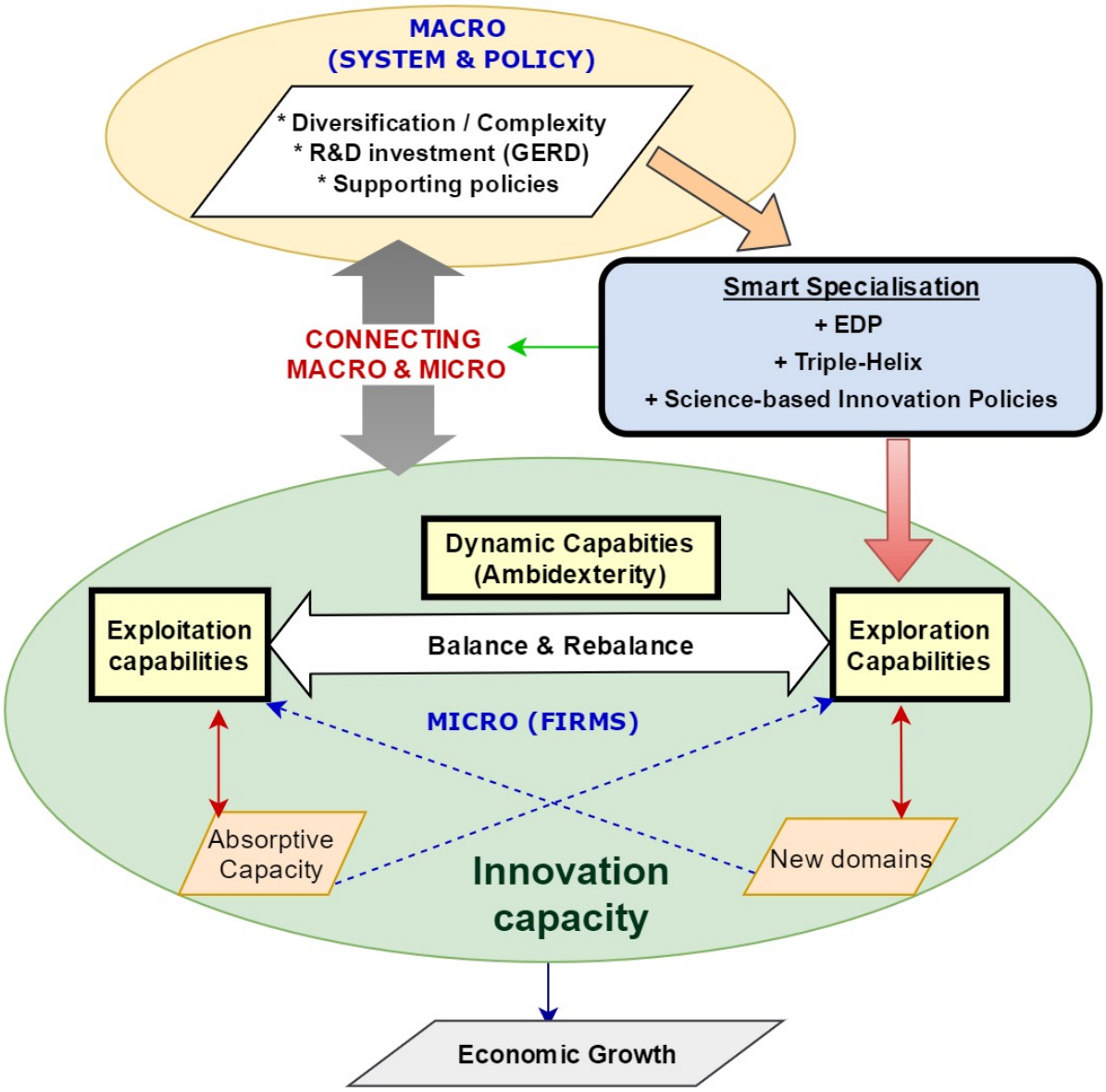
5.1. Connecting macro and micro: A conceptual framework

Economic restructuring process, in our definition, is diversifying the economy by combining complexity and investing R&D in industry with the support of science and innovation policy. Smart Specialisation Strategy is the approach for enabling this process, which can be conceptualized as in Figure 15 below. There are two key points in this process:

a) Innovation actors (micro level) need to acquire sets of complex capabilities: including *exploitation capabilities*, *exploration capabilities*, and *dynamic capabilities* which help balance the exploiting and exploring activities.

b) Smart Specialisation is the strategy to connect macro level (system, policy) and micro level (innovation actors, firms): This strategy is the combination of entrepreneurial discovery process (EDP) using triple-helix approach with the support of science and innovation policies.

Figure 15. Economic Restructuring Conceptual Framework



a. Acquiring sets of complex capabilities at micro level:

The engine of a country's economic growth is its innovation actors. These actors together create the innovation capacity of that country via their ability to innovate. This ability to innovation is based on sets of complex capabilities, including exploitation capabilities, exploration capabilities, and dynamic capabilities as shown in Figure 15. Dynamic capabilities,

including ambidexterity, are the survival requirements for balancing and rebalancing exploration and exploitation.

Norway has been fortunate with the success with O&G, its exploitation capabilities are very good, illustrated by the development rate of the country from 1996 until now. One of the outcomes from exploitation is the absorptive capacity which is the ability to recognize the value of new external information, assimilate it and apply to innovation activities (Cohen & Levinthal, 1990). This absorptive capacity is prerequisite for exploration activities, at both firm level and country level. However, after the drop of O&G price, it is realized that Norway's ability to explore the next competence is still rather weak as analyzed in OECD report. To enhance Norway's exploration capabilities, Smart Specialisation Strategy in which the core process is entrepreneurial discovery process supported by triple helices as well as science and innovation policy is an appropriate strategy. The outcome of EDP is the discovery of new domains of knowledge, skills, and business opportunities. New domains should be nurtured and developed until it can be exploited for future growth.

Figure 15 illustrates this point by drawing the outcome of exploitation capabilities as absorptive capacity, and connecting this capacity to exploration capability. Meanwhile, the outcome of exploration capabilities is new domains which will feed into exploitation capabilities.

The three capabilities create innovation capacity of innovation actors – which are the engines for economic growth and development.

b. Connecting macro and micro: Smart Specialisation Strategy

The strategy for connecting macro and micro is a national level policy of smart specialization promoting EDP, based on cooperation between public sector institutions, private entrepreneurs and research institutions and networks.

Seen from the entrepreneur, EDP is exploration of opportunities. Seen from the public sector, it is about diversification of the economy through the creation of new sectors and clusters of growth. This should be done in areas which may profit from proximity to the existing industries and resources in the Norwegian economy. In other words, there is no point in making something new which easily slips away. In this respect, the continuation of strategies related to natural resources, such as the Norwegian Government blue strategy, and various initiatives in the direction of green shifts should be seen as possibilities.

EDP is a collective process and it should be based on strengths, which can be found through the process of self-discovery. In this process, dispersed entrepreneurial knowledge should be searched, mobilized and integrated. New R&D and innovation activities will be needed to complement existing strengths to create future competitive advantages (Foray 2015, p. 5). They can be based on both local assets and extra-regional capabilities.

A new regional capacity may be needed to initiate structural changes like diversification, transition, modernization, or the radical foundation of industries and/or services (Foray 2015, p. 1). EDP defines a process of diversification through concentration of resources and competences in new domains which represent possible paths for the transformation of regional productive structures.

The transformation of these productive structures and capacities requires new resources, new technologies and new competencies which can be generated within the same area although they may also come from outside. Resources should be concentrated in specially selected domains dealing with particular kind of technology, fields, disciplines, and sub-systems within a sector or at the interstices of different sectors. When the resources are concentrated in the selected domains, new activities can be created which enable and facilitate the transformation and renewal of the economy. This can be the basis for a unique competitive advantage.

It this way, the "self" in EDP is a large and heterogeneous set of actors involved in the process of discovering which domains of R&D and innovative activities a region should move into to construct its future. This should be carried out in partnership between the government and the private sector. Therefore, the process of entrepreneurial discovery is a central tool to solve the information problem that the government alone cannot solve (Foray, 2015) thanks to its strong learning dimension that help to open and explore new domains of opportunities.

5.2. Structural transformation for economic growth:

Economic restructuring process in Norway can be implemented by exploration and exploitation activities in both levels, micro and macro. This is a process of balancing and rebalancing these parallel activities through integration platforms as shown in table 7. These activities are interwoven into each other, for example, exploitation activities at macro level can include exploration activities of micro level.

The strategy of changing Norwegian's economic structure in table 7 can be understood as a combination of 3 parallel processes:

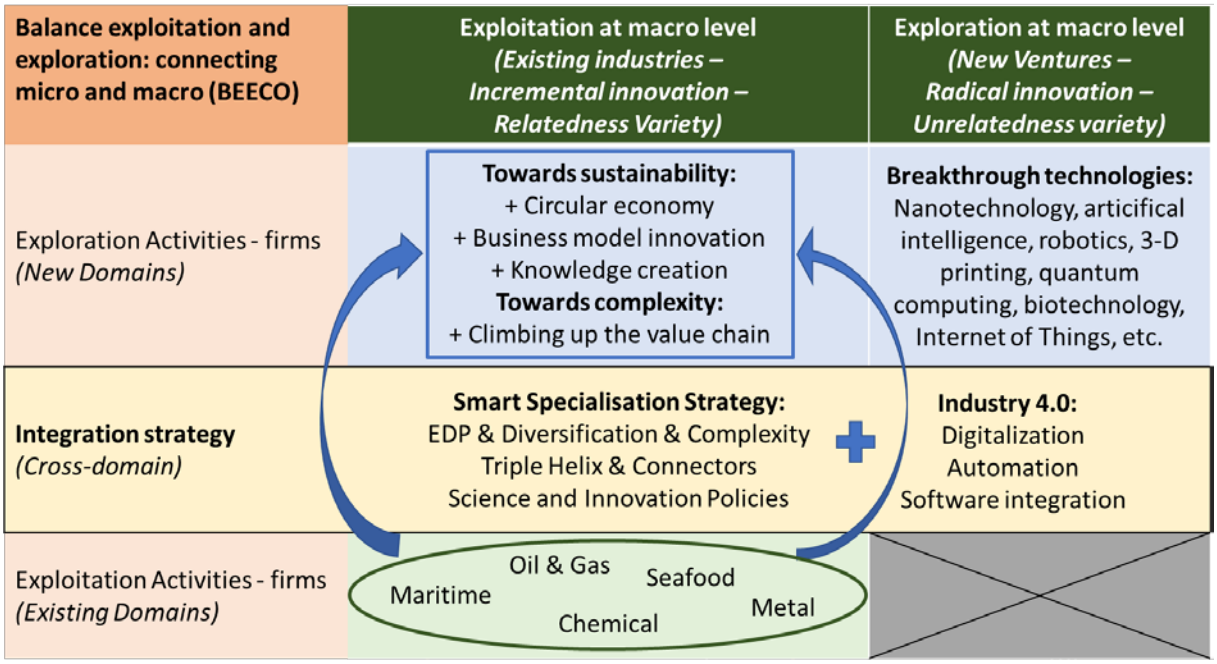
(i) **Exploitation of existing strengths**. This exploited orientation at the macro level, based on the existing strengths in the Norwegian economy, i.e. oil and gas, seafood, maritime/ mechanical industries, metals and chemicals, is built on both exploitation and exploration activities of micro level. At micro level, innovation actors can strengthen their competence in their existing domains of business, for example, daily operating activities of firms and organizations. Meanwhile, innovation actors conduct exploring activities by recombining knowledge and applying such knowledge recombination to related domains. The strategic directions for Norway to exploit their existing strengths, which are based on natural resources, focus towards sustainability and complexity principles. Topics to considered in this direct are circular economy, business model innovation, knowledge recombination, or climbing up the value chain.

(ii) **Exploration of new domains and business opportunities.** This orientation requires a joint effort of both levels, micro and macro. Norway should seek for radical innovations based on breakthrough technologies such as: Nanotechnology, artificial intelligence, robotics, 3-D printing, quantum computing, biotechnology, Internet of Things, etc. The collaboration between micro and macro level actors requires smart specialisation strategy.

(iii) **Balancing exploration and exploitation and connecting micro - macro by integration strategies.** Integration strategies here refer to smart specialisation strategy and building infrastructure for Industry 4.0 (the fourth industrial revolution), such as digitalization,

automation, and software integration. The aims of integration strategies are two-fold: Coordinating two parallel activities of exploration and exploitation; and connecting activities at micro level to macro level and vice versa. For example, infrastructure for industry 4.0 such as digitalization, automation, software integration are fundamental foundations for strengthen business activities at firm level as well as innovation system at country level. Meanwhile, it facilitates the coordination between exploring and exploiting activities in terms of retaining specialized knowledge in exploitation for the purpose of knowledge recombination in exploration. It can also help disseminate best practices of exploration to the exploitation area. Another example is how smart specialisation strategy can balance explore-exploit and connect micro-macro. EDP is a joint-effort of both macro and micro actors to explore new domain of activities, which can include radical innovation belonging to un-relatedness variety. By increasing the exploration activities, EDP can help Norway to rebalance its current bias position towards exploitation.

Table 7. Balancing exploitation and exploration by connecting micro and macro



6 EXPERIMENTAL INNOVATION POLICY: A RESEARCH AGENDA

The research agenda identified in this scoping paper is responding to these three questions:

1. HOW? How can the Norwegian economy diversify and develop new domains, based on existing strengths?
2. WHAT? What are the preconditions for a transition towards cross-sector networks and systems of innovation?
3. WHO? Who could be the coordinator in this transition process? We discuss the role of the research councils in connecting micro and macro levels in the process of economic restructuring.

This part summarizes key points for a research agenda on the topic of economic restructuring in Norway, and discusses the future direction for research.

6.1 HOW CAN THE NORWEGIAN ECONOMY DIVERSIFY?

6.1.1 SMART SPECIALISATION STRATEGY

Implementation of smart specialisation strategies should not be seen as a state planned top-down process. It is not based on a rigid application of an equally static set of policy tools, decided once and for all at the beginning of the planning cycle. Neither should it be perceived as an incremental process of implementation, with no long-term vision.

Implementation of a strategy of smart specialization can be seen as an experimental *'trial and error'* process of how new sectors and clusters might be created (entrepreneurial discovery process, or EDP). Coordination of EDP is expected to improve the failures identified by the OECD, and the three “transition imperatives”. Search leading to discoveries is expected to be based on an empirically verified analysis of how existing domains might form the basis of exploration into new related varieties, new sectors and clusters building on domestic strengths.

It should also take into consideration how this dynamic of related varieties in Norway and regions in Norway can access and exploit global networks and systems of innovation which might provide new emerging technologies where Norway is weak today. The national system of innovation in Norway should not create micro-copies of “all new interesting topics” which are “out there”. There simply are too many, and the critical mass inside Norway would be too small. It should specialize on new ventures which might get a firm embedding in the country, through commercialization. But this specialization should not ignore new disruptive technologies which may hit us in the future. The solution is “absorptive capacities”, global networks which enables Norwegian institutions, firms and clusters to connect to global frontiers, monitor the deep future, beyond the horizon of exploration of most contemporary industrial actors, and bring home and commercialize whatever we need, as soon as it is ready for exploitation.

Smart Specialisation builds on the principles of new industrial policy of Rodrik (2004). Successful application of this strategy should consider these principles:

1. **Incentives should be provided only to new activities**. The main purpose of the policy is to diversify the economy and generate new areas of comparative advantage. New refers to both products that are new to the local economy and to new technologies for producing an existing product.
2. **There should be clear criteria for success and failure**. Industrial policy is an experimental policy, and not all investments will pay off.
3. **There must be a built-in sunset clause**. There should be support by default and a clear statement ex ante what constitute success and failure, including a sunset clause for withdrawing support after a while.
4. **Public support must target activities not sectors**.
5. **Activities that are subsidized must have the clear potential of providing spillovers** and potential to crowd in other, complementary investments.
6. **Competent authorities and agencies of implementation**. The agencies carrying out promotion must maintain channels of communication with private sector. Public officials should have a good information base on business realities.
7. **Mistakes will occur**. Usually, public sector authorities focus on risk avoidance. Instead, they should take risks and be prepared to lose money. The objective should be minimizing the costs of the mistakes when they occur.
8. **Promotion activities need to have the capacity to renew themselves so that the cycle of discovery becomes an ongoing one**.

This industrial policy cannot be carried out by the industry policy sector alone. On the contrary, it should be based on cross sector cooperation, involving industrial, science and regional policymakers. It should include regions, the state and transnational networks.

This integration could be based on the six phases of smart specialization as suggested by the RIS3 guide (Foray et al., 2012, p. 27).

(1) A **shared vision** for the future. Since stakeholders often live in different worlds in terms of their rules and modes of operation, coordination is rather difficult. To formulate a vision of a connected region requires sufficient social proximity between the stakeholders.
(2) Analysis of the **potential for innovation**: survey and gap analysis. Gap analysis is one possible method to analyse the bottlenecks in the RIS. It is expected that it would identify core positions in the regional economy and builders in the TH, connecting science, politics and visionary entrepreneurs.
(3) **Governance**: building a shared knowledge platform. Improving connectivity is a learning process that needs coordination and a learning organization. In learning organizations, temporary organizational proximity is created when partners are connected, and the shared vision is implemented and extended.
(4) **Identification of priorities**: Stakeholders should be engaged with questions about partners that will identify gaps in the innovation structure. The findings must then be verified in a structured dialogue. The bottlenecks in the innovation system are the largest gaps between expectations and experiences found in the gap analysis, and it is important to discuss the policy interventions available to bridge these gaps and form a platform.
(5) **Definition of policy mix**: implementation. Policy interventions can be either part of a larger programme, just one project or investment, or a change in regulation. The priorities would, however, most likely involve the promotion of cooperation through mutual projects.

(6) **Starting a new circle**: monitoring and evaluation with the help of indicators of success and failure.

The experiences from this process of experimentation is expected to generate new empirical insight in the preconditions for the transition suggested by OECD. This creates a number of related questions which deserve attentions for future research direction:

- How can collective triple helix search for new opportunities for development be organized successfully? How open can this process be, how can relevant stakeholders be mobilized on board and how should this collective search be organized in order to achieve results.
- How can these experiences of experimentation improve our understanding of innovation through related varieties and other processes?
- Norway cannot be excellent in everything – there is a need to specialize. We have "blind spots" in emerging areas beyond the immediate horizon of our leading firms. What are the strengths of the Norwegian system of innovation in the global economy, where are the weaknesses?
- What are the successful and not so successful mechanisms of knowledge transfer and new knowledge creation (such as for instance innovation platforms)?
- We are talking about an experimental process where the public sector is carrying a high risk. How can costs of exploration and considerations of exploitation be balanced at different levels, inside firms and in the public sector?
- To what extent and how is it possible to overcome market failure problems through public-private partnerships?
- How can efficient systems of monitoring, evaluation and policy learning be organized?

6.1.2 CLIMBING UP THE VALUE CHAINS:

Climbing in global value chains (GVC) is a demanding, long term strategy to increase complexity and generate new growth opportunities. The comparative advantage of the industry can be assessed and its degree of participation within the industry GVC can be examined, including establishing those locations that serve as its main sources of input and the destinations of its output. Thus the linkages of the industry and their extent can be established. Such an analysis could point to opportunities for maintaining, extending and/or deepening the region's positioning on the GVC.

A country can ascertain others that occupy significant parts of the industry value chain, how strong their positions are and whether those clusters of GVC activity are similar and complementary to their own. Taking account of previously-identified linkages, this can indicate whether there could be opportunities to capitalize on complementarities in other locations, and the development of inter-/macro-regional and trans-European linkages.

Since the data required at the digging stage may be unavailable or indeed difficult to access, it is necessary to identify conduits/boundary spanners that are connected to the industry and have a deep knowledge of the industry cluster and its characteristics. These spanners are likely to be found within national and regional development agencies and/or enterprise development agencies. For each location, such individuals might be assigned specific S3 responsibilities within

the context of the industry GVC. Platforms – real and virtual - would need to be developed to facilitate engagement among such conduits/boundary spanners so that opportunities for intra-regional industry GVC linkages can be precisely identified and pursued, and that match-making takes place.

A number of general principles can be summarized as Engaging, Anticipating, Assessing and Responding (EAAR):

i. *Engaging* with the industry and its stakeholders on a continuous basis,
ii. *Anticipating* the likely evolution of the industry globally,
iii. *Assessing* the challenges and opportunities that are likely to ensue from future industry trajectories, and
iv. *Responding* to those challenges and opportunities in a proactive manner.

The process of Engaging, Anticipating, Assessing and Responding (EAAR) is required to be followed on an on-going basis and must involve active stakeholder participation. The following are areas that are key for the development of regional position in global value chains:

1. The provision of a compatible and supportive environment via a relevant infrastructure that encompasses a robust regulatory framework, research and technology and education.
2. The upgrading and sustaining of a regional/national innovation system.
3. The development of the requisite human capital pool.
4. The supporting and nurturing of collaboration among all stakeholders.
5. The engagement in the upgrading of existing activities within industry.
6. The anticipating and targeting of areas of growth within the industry.

This model is based on experiences from Ireland. Future direction for research should explore the condition for this approach to work in Norway in term of increasing the complexity of the Norwegian economy.

6.2 WHAT ARE THE PRECONDITION TO PROMOTE CROSS-SECTOR INNOVATION?

Cross sector innovation is based on sharing of tacit and codified knowledge from different sources, such as different sector systems of innovation, different scientific disciplines and industrial actors with different forms of skills and expertise. This knowledge sharing will have to be located, in a physical or virtual place, such as for instance a seminar room, a conference or a laboratory where industrial experiments are undertaken. The organization of this meeting should be guided by institutions and actors who are able to stimulate openness, trust and knowledge sharing. A core part of this motivation of knowledge agents should be oriented towards a solution of a common challenge or a common problem. Meetings like this may have to be repeated, in a cumulative way, which leads to a deeper, cross disciplinary understanding of the complex challenges and questions. Gradually, through this process, various forms of tacit and codified knowledge from different disciplines and sectors will become integrated and create new knowledge of the challenge, a “model” or “archetype”, which eventually makes practical steps forward possible. This type of process might be organized within a large corporation, which has all the knowledge components inside itself. This is a typical strategy of innovation in Japanese

companies. In Europe, a facilitating mechanism may be seen as an “innovation platform” which acts as an environment for gathering different type of knowledge, from different sectors and disciplines. An innovation platform is “a physical or virtual forum established to facilitate interactions, and learning among stakeholders”, the goal of innovation platform is “joint exploration of opportunities and investigation of solutions” leading to innovation (Adekunle et al, 2010, p.2). This is the precondition for making cross-sector innovation happen since an innovation platform can act as an environment for gathering different knowledge type from cross-sector and multi-disciplinary research.

Innovation platforms should be built based on the topic of societal challenges to facilitate cross-sector knowledge exchange towards solving challenges in current global societies. The participation from triple helix actors is essential to sustain the platform. A strategic innovation platform can be set up at the national level or regional level to promote both incremental and radical innovation in Norway. This is the environment where knowledge is created and recombined, which is crucial for making innovation happens. An innovation policy center on economic restructuring can be a good example of innovation platform that can promote cross-sector innovation in Norway.

A core difficulty is motivating cross-disciplinary research among scientists. In this respect, a recent study undertaken by Technopolis emphasizes a mixture of below elements can help enable researches to cross disciplinary lines (Davé et al., 2018):

1. Co-location
2. Build “virtual networks” of researchers
3. Top-down strategic approaches
4. Bottom-up investigator-led approaches

However, innovation platforms capable of generating new industries should include strategies of related variety, the discovery of new opportunities, based on existing strengths in the Norwegian economy. This makes participation from triple helix actors essential, both in terms of public sector venture capital providing risk taking and funding of experiments, as well as industrial actors ready to upscale and industrialize. Innovation platforms with ambitions to create new industries should also include science – society interaction, and accordingly a quadruple helix approach.

Future research should look at these practical issues for establishing functional innovation platforms, such as

- What kind of institutional framework is optimal for mobilization of triple and quadruple helix actors?
- What is an optimal balance between virtual platforms and physical places?
- How to facilitate interaction among them (contacts, meeting logistics, and communication channels)?
- How to secure cumulative learning across different meetings and physically located events?
- What are governance and management guidelines for innovation platform?
- What are the indicators of effective innovation platforms in terms of outputs and impacts?

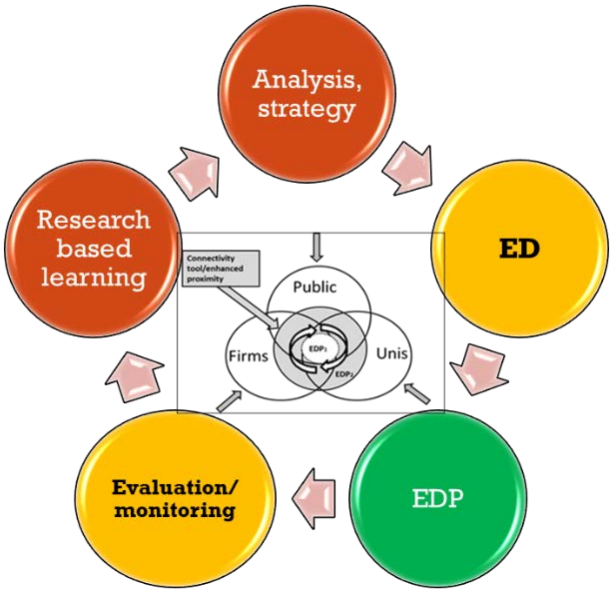
6.3 WHO: THE RESEARCH COUNCIL AS THE COORDINATOR OF A LEARNING PROCESS

An agenda of smart specialisation implemented through entrepreneurial development processes is demanding. The point of departure is a sectorized state, with coordinating mechanisms between ministries. Smart specialization is an experimental process involving public sector authorities, industrial clusters, firms, entrepreneurs, research institutions and researchers. They are expected to be collectively involved in feedbacks and learning from their experiments. What is the role of public sector authorities? Let us assume that the core coordinating institution is the Norwegian Research Council.

As mentioned above, implementation of Smart Specialisation Strategy should not be seen as either a state planned top-down process, or an incremental process of implementation, with no long-term vision. It should be designed as an experimental 'trial and error' process based on empirical analysis of EDP implementation.

The analysis underpinning the strategy should not be seen as carved in stone. It should lead to entrepreneurial discoveries of new opportunities, some of them close to home, some based on transnational networks. These discoveries should not be made inside the walls of ministries, they should involve entrepreneurs, science institutions and public- sector program operators and financers. During this experiment, design, visions and long-term goals are regarded as hypotheses which can be confirmed as well as rejected during the implementation and monitoring of effects. The closing of this feedback loop, through analysis of outcomes and the process of learning, where success and failure is used to correct analysis and strategy is the current agenda of innovation policy relevant research. This suggests a need for built-in feedback loops connecting different process elements: implementation, actual impacts on the innovation ecosystems (to be observed through monitoring and evaluation), the critical analysis of the strategy, as well as design and governance mechanisms. A crucial aspect is research-based learning from the experiences, which are expected to feed directly into strategy updates and revisions, as some experiments fail, and some succeed. The circle of collective learning process is illustrated in Figure 16.

Figure 16. Collective learning process



This is an experimental process of trial and error, therefore, future direction for research on coordinating institution needs to look at two crucial questions:

- How can we rebalance the triple helix, make better connections between firms and R&D institutions, give firms incentives to do more R&D and give firms a stronger position in R&D institutions?
- How is it possible to reorganize the system of innovation in a way which overcomes sectorization and accordingly solves the transition imperatives of OECD

Below is a summary of the research agenda in our scoping paper:

Table 8. Summary of Research Agenda

Transition to a more diversified economy driving economic growth			
Objectives	**Challenges**	**Research questions**	**RESEARCH AGENDA**
Promote the diversification of the economy	Too much specialization on oil and gas	1. How to diversify Norwegian economy?	Smart Specialisation Strategy (EDP, Triple Helix, science and innovation policy, climbing up the value chain)
Foster a more competitive innovation system	Sector systems of innovation	2. What is the precondition for cross-sector innovation?	Innovation platforms supporting entrepreneurial discovery processes, cross sector innovation networks
Advance inter-sector policy coordination	Ministerial coordination	3. Who could be the coordinator?	A stronger role for the Norwegian Research Council

7 CONCLUDING REMARKS

This scoping paper identifies and describes approaches that are relevant for economic restructuring processes in Norway. It outlines a research agenda supporting innovation policy for restructuring of the Norwegian economy.

The paper also identifies and explains the important remaining knowledge gaps and their relevance, and it describes how the knowledge gaps can be overcome through an experimental strategy of Smart Specialization, including a research agenda supporting these strategies. In doing so, the paper is intended to inform debate and policymaking on economic restructuring, as well as guiding future research on economic restructuring through innovation.

This future research beyond the scope of the project is expected to enable the Norwegian Research Council to play a pro-active role in an experimental approach to innovation-driven restructuring of the Norwegian economy. The Norwegian Research Council should be able to discover and address tensions between innovation strategies in the business sector and national-level policymaking. It must be able to team up with and support entrepreneurs and firms exploring new, so far unused and unexplored opportunities in the economy. This means that the Norwegian Research Council should be able to act based on an in-depth, empirically grounded understanding of the barriers which prevent firms from discovering and exploiting new

opportunities and lock them into short-term strategies of exploiting existing markets. In this respect, a key area of further research in continuation of this project is the analysis of the hidden potential of the Norwegian economy, given its current strengths, applying new methods and insights developed by evolutionary economists like Foray and others. In this way, the Norwegian Research Council will be enabled to develop a forward-looking strategy in partnership with private sector entrepreneurs who search for new opportunities.

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